TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

MIKKO NURMINEN

EFFECTS OF EMOTIONAL DESIGN AND GOAL ORIENTATION ON STUDENTS' EMOTIONS AND LEARNING OUTCOMES IN UNIVERSITY PROGRAMMING EDUCATION

Master of Science thesis

Examiner: Prof. Petri Ihantola, Heli Väätäjä
Examiner and topic approved by the Faculty Council of the Faculty of Computing and Electrical Engineering on 4th May 2016

ABSTRACT

MIKKO NURMINEN: Effects of emotional design and goal orientation on students' emotions and learning outcomes in university programming education
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This thesis studied the effects students' goal orientations and applying Emotional design to learning materials had on their learning outcomes, emotions, and students' perception of the qualities of the learning materials.

The study material included the online exercise material and online questionnaires before and after the exercise material. Two variants of the exercise material were created for the study: the treatment group used an emotional design variant of the material with illustrations that had colours and human-like shapes, while the control group used a traditional material variant with greyscale illustrations.

There was a statistical connection between the learning material variant used and the change in students' negative emotional states. There was no such connection for change in positive emotional states.

Students using the emotional design material variant rated the beauty and creativity of their material version higher than students using the traditional material variant rated that version. If the learning materials would have been designed by professional designers using Emotional design, the results might be more pronounced.

In the study data there was no correlation between students' goal orientations and changes in their emotions or their learning outcomes. Though emotions' and learning outcomes' connection to the goal orientation was not found in this study, further research on the matter, maybe in different learning contexts, might give different results.

TIIVISTELMÄ

MIKKO NURMINEN: Emotional designin ja tavoiteorientaation vaikutus opiskelijoiden emootiohin ja oppimistuloksiin ohjelmoinnin opetuksessa yliopistotasolla
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Tässä diplomityössä tutkittiin opiskelijoiden tavoiteorientaation ja Emotional design-menetelmän vaikutusta opiskelijoiden oppimistuloksiin, tunteisiin sekä oppimateriaalin koettuihin ominaisuuksiin.

Tutkimusosio muodostui opiskelijoiden verkossa opiskelemasta viikkoharjoitusmateriaalista sekä siihen liitetyistä verkkokyselyistä. Viikkoharjoituksen verkkomateriaalista luotiin kaksi versiota: testiryhmälle näytettiin materiaalin Emotional design-versio, jossa kuvitukseen oli lisätty värejä ja ihmisenmuotoisia hahmoja. Verrokkiryhmälle näytetyssä perinteisessä materiaalissa oli harmaasävykuvitus.

Tuloksissa oli tilastollisesti tarkasteltuna negatiivisten tunteiden vähenemisen voimakkuuden ja oppimateriaaliversion välillä yhteys, positiivisten tunteiden muutoksiin oppimateriaaliversiolla ei ollut vaikutusta. Opiskelijat pitivät Emotional design menetelmällä luotua materiaaliversiota kauniimpana ja luovempana kuin perinteistä versiota. Emotional desingin vaikutus oppimistuloksiin tulisi mahdollisesti paremmin esiin, jos oppimateriaalin muokkauksessa käytettäisiin ammattitaitoisia suunnittelijoita.

Vaikka tässä diplomityössä ei havaittu tavoiteorientaation ja tunteiden muutoksen tai oppimistulosten yhteyttä, niiden välisen korrelaation tutkiminen jatkotutkimuksissa toisi lisätietoa.

PREFACE

This thesis was done at my alma mater, Tampere University of Technology, at it's department of Pervasive Computing.

I wish to sincerely thank Petri Ihantola and Heli Väätäjä, the supervisors of this thesis, for their valuable input and guidance and endless patience throughout this odyssey of a thesis. Hey, I got the variables in the end!

All other colleagues at the Pervasive Computing department too deserve what in modern Finnish parlance is called 'isot kädet' for making my time and work at the department fun and interesting.

Special heartfelt thanks go out to my family and friends, especially to my wife Noora and son Eero. Put the kettle on, sweethearts, daddy is coming home!

Tampere, 18.5.2016.

Mikko Nurminen

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1. INTRODUCTION

Emotional design is a design concept formulated by Norman (2005). Norman argues that during the design process designers should concentrate in the emotional response the product induces in users and not focus only in the functional aspects of the product. The underlining working mechanism for the concept is the effect the emotional system of the human mind has on the cognitive system. This mechanism is based on the function of emotions in humans, which is to help humans adapt to their surrounding by giving a quick assessment of phenomena humans come across, to assess whether the met phenomenon is good or bad, desirable or something to be avoided. Thus emotions can direct and colour the higher levels of cognition.

Pekrun, Goetz, Titz & Perry (2002) describes the same mechanism of emotion affecting cognition working in education. Use of emotional design to produce learning materials has been studied in recent years in several studies by Um, L., O. & Homer (2012), Mayer & Estrella (2014), Plass, Heidig, Hayward, Homer & Um (2014), Park, Knörzer, Plass & Brünken (2015), Heidig, Müller & Reichelt (2015), and Navarro, Molina, Lacruz & Ortega (2015). An example of a study that did find an effect when applying emotional design to learning materials is a study by Plass et al. (2014). They studied the effects colour and shape had on students' affects and learning outcomes. The study found that the design of the materials had an effect on the learning outcomes as they affected positive emotions in students. The use of shapes resembling human faces also was found to lead to better learning outcomes. Echoing the results of that study, a later study by Mayer & Estrella (2014) on US college students found that students in a group that used materials with graphics that had elements pictured in them given human characteristics and appealing colours had better learning outcomes of German Education graduate students. These studies show the potential of applying emotional design to study materials to lead to better learning results. The results and methods of these studies provide a basis for the research in this thesis. As a caveat, it is worth noting that while in these studies the study materials designed using emotional design were shown to produce emotional

responses and leading to improved learning outcomes, the demonstrable effects found in these studies are mostly moderate and rest of the studies found little or no effect.

Students have different goals that motivate them when they are engaged in their studies (Dweck & Leggett 1988). This has been theorized to affect their learning results and emotional states related to learning situations. Researchers make a rough division to two groups: to those students whose goal is to achieve high grades and to those whose goal is to learn the subject matter. The effect students' goals have on their learning results and emotions have been studied, see for example studies by Kaplan & Maehr (2007) and Urdan, Ryan, Anderman & Gheen (2002). These studies have found that the goal of striving for grades leads to stress, but also achieving those grades, which would lead to for example better measurable test scored but negative affects during the learning process. Other students whose goal it is to focus on learning the study material have shown more ability for deep learning and display positive affects, and to better endure failures at a task. These results form the basis of understanding students' goals as studied in this thesis and the interpretation of the results.

Based on the directions set by previous research in the role of emotion and goals in the learning process this thesis focused on the differing goals of students and the use of emotional design on learning materials, and the effect these materials had on the emotions and learning outcomes of the students.

This thesis is structured in the following way:

- In the second chapter emotions, emotional design and goal orientation are defined and shown being linked to learning.
- In the third chapter the research questions are presented, research methods that were used described and the research plan shown.
- In the fourth chapter the results are presented.
- In the fifth chapter the results are discussed and conclusions shown, the study that was conducted is evaluated and directions for future work proposed.

2. BACKGROUND

This chapter gives definitions for emotions and goal orientation. The roles they play in learning are explored.

2.1 Emotions

Emotion as a term has no universally agreed upon definition. Kleinginna & Kleinginna (1981) found 92 definitions and 9 sceptical statements in literary review of emotion research literature. Based on these definitions and statements the authors the proposed following definition for emotion:

> "Emotion is a complex set of interactions among subjective and objective factors, mediated by neural/hormonal systems, which can:
>
> - give rise to affective experiences such as feelings of arousal, pleasure/displeasure;
> - generate cognitive processes such as emotionally relevant perceptual effects, appraisals, labelling processes;
> - activate widespread physiological adjustments to the arousing conditions; and
> - lead to behaviour that is often, but not always, expressive, goal directed, and adaptive"(Kleinginna & Kleinginna 1981)

When forming another definition for emotion Izard (2010) used questionnaires to collect differing definitions of emotion and it's primary function, activators, regulation and connection to actions from 34 scientists studying emotion. The author found that no synthesis to single definition was feasible. However, the components of emotion that were identified broadly support Kleinginnas' definition, but also expand it.

A concise definition for emotion could be formulated as: "The working mechanism of emotion in human beings can summed up as: based on new sensory observations individuals physiological systems enact affective experiences and cognitive processes which help the individual adjust to these new observations." In this thesis we use this definition for emotion.

The definition of emotion doesn't give many clear metrics to measure emotions by, other than the ones measuring the neural/hormonal systems or their immediate effects and emotional dimensions such as valence and pleasurableness of the emotional state. Measurement of emotion has been facilitated by defining theoretical models of emotion. These models are used as theoretical basis when designing methods of measuring emotion. In the models the complex human emotional state has been simplified to measurable qualities, that research methods can capture. The qualities chosen for a single model together describe the individuals emotional state as a whole. Broadly these qualities have been chosen in two differing ways: using either categorical, basic emotions or dimensions of emotion. A concise review of emotion models can be read in an article by Calvo & D'Mello (2010). Short descriptions of the categorical and dimensional models are given next.

Categorical models use a set of separate basic, discrete emotions as measurable components which together describe the emotional state as a whole. Basic emotions are those that manifest themselves similarly in all humans regardless of cultural context. A basic emotion manifests itself in facial expressions and neural and bodily reactions. The number of basic emotions used differs between studies and has not been established. Number of basic emotions has varied at least between 2 from Weiner (1985) and 15 from Ekman (1999). Shaver, Schwartz, Kirson & O'Connor (1987) list love, joy, anger, sadness, fear, and surprise as primary emotions. Contrasting this, a later study of facial expressions by Jack, Garrod & Schyns (2014) found that fear and surprise are similar, as are anger and disgust, which led them to four basic emotions: happiness, sadness, fear/surprise and anger/disgust.

Dimensional models use a combination of a number of dimensions to describe the emotional state. Dimensions are not emotions in themselves, but describe some quality of the whole emotional state of individual. Three dimensions of valence, arousal and dominance have been established since the late 19th century as noted by Bradley & Lang (1994), even though dominance is sometimes left

out (Russell 2003). Valence dimension is used to measure how pleasurable the emotional state is, arousal used to measure how intense the emotional state is and dominance is used to measure how much sense of control the person feels. Numeric values used to represent the value range of the dimension can be chosen arbitrarily. These dimensions can be seen as forming the axes of 3D emotional space, the space describing a full set of emotions. The values a person reports or displays for dimensions can be used to place them in this emotional space.

The results from the models can be used together as basic categorical emotions can be deducted from the dimensional models or used to describe emotions placed in the 3D emotional space. If we take the emotion of joy as an example, joy would rate in valence dimension as pleasurable, in arousal as highly aroused and in dominance as dominant. Indeed, Ekkekakis (2012) states that the dimensional models must be integrated with the categorical models. This follows from the argument that the dimensional models can only capture *core affects*. Core affects correlate with dimensions of valence and arousal of dimensional models (Russell & Barrett 1999). The method of integrating the models is to first use dimensional models to place the emotion to 2-dimensional or 3-dimensional space, and then the results can be interpreted using basic emotions categorical models.

Terminology used in the field of emotion research is not consistent between studies. Terms *affective experience* and *feeling* are used in the Kleinginna's definition of emotion and are used in emotion research literature with terms such as *mood* and *attitude* and *core affect*. The exact definitions and relationships between the terms used is debated, see for example Shouse (2005), Gross (2010) and Ekkekakis (2012). According to Shouse (2005) feelings depend on the previous experiences of the person and are thus personal, whereas affects are prepersonal, non-conscious and adds appraisal of intensity to experiences while emotions are outward displays of feelings. The definition of all the terms and their relationships is beyond the scope of this thesis. It is however noteworthy that when measuring emotions is later discussed, methods that are used might actually measure some other affective experience than emotion as it is reflected by the concise definition of emotion presented in this thesis.

The way emotions can aid or impede learning has been widely studied. A literary review by Pekrun et al. (2002) of articles published between the years 1974-2000 found over 1300 articles studying emotions' effects of learning and achievement.

Even though emotion is theorized as having a complex effect on learning, their literary review found that articles overwhelmingly focused only on test anxiety students feel during their exams, while other singular negative and especially positive emotions and the interaction of the emotions were found to have been studied much less. This might be because emotions are often seen as hindrance to learning and cognition, as noted by Dirkx (2001). In their study Pekrun et al. (2002) defined emotions that have a central role in learning and achievement as enjoyment, hope, pride, relief, anger, anxiety, shame, hopelessness, and boredom. Even though all of these nine emotions are not found in any single one basic emotion model, the way emotional state is defined as separate emotions echoes categorical emotion models. Then a measurement of each emotion would be necessary to capture the emotional state of a student. In a contrasting study that is more in line with dimensional emotional models D'Mello & Graesser (2012) measured cognitive disequilibrium felt by students when studying. In this method the usual mental and emotional state of a student while studying is their equilibrium. A deviation from this emotional equilibrium is caused when studied matter or its presentation causes confusion in students by having contradictions, obstacles to goals, or other impasses. These two contrasting methods show how emotion can be measured in the context of learning. Unfortunately, the tools for applying them were not available for the study conducted for this thesis, making the use of more general use methods necessary.

There are several methods available for measuring emotions. One way of categorizing the available measurement methods for emotion is given by Desmet (2005) who divides them to non-verbal or verbal methods categories. All of the methods measure one or more of measurable variables of emotion that can be grouped between behavioural, expressive, physiological and subjective categories. For all of the categories there are methods available for studying them.

Non-verbal methods measure physiological or expressive components of emotion. These can be objectively measured and interpreted to emotional states. Physiological responses include blood pressure and pupillary constriction and dilation. Expressive component is comprised of facial expression, human voice and body language. Non-verbal methods have the advantage of being language-independent and thus can be used in cross-cultural context. Desmet (2005) lists problems in using these methods as the limited accuracy in case of discrete emotions and difficulty in differentiating simultaneously appearing emotions.

Non-verbal methods were not included in the study conducted for this thesis. Two most pressing practical difficulties with using the methods were the lack of needed measuring equipment and unfamiliarity with the methods. The study was conducted on-line and the students could freely choose time of taking part in the test within a set time frame. The equipment and instruction on their usage should have been given to students prior to this. Arrangement was seen as being too demanding for the students and possibly leading to failures in using the equipment.

Verbal methods use self-reporting of emotions by participants of the study. These methods can be used to measure the subjective component of emotion, and ask participants for assessment of their conscious experience of emotional state. Often these methods use rating scales to rate the experience of emotional state. The words used to describe emotions in these methods are difficult to translate correctly to different languages, because of cultural considerations in mapping to word describing exactly the same emotional state.

Verbal methods were used to in the study conducted because of their easy applicability to on-line environment as on-line questionnaires. During the design of the research set-up the amount of questionnaires presented to the students during the online exercise session was deemed high and the students expected excitement would be low when faced with the questionnaires they could see as extra work. These considerations demanded the questionnaires be relatively short and easy to answer. I-PANAS-SF and Attrakdiff 2 short were chosen because they fill these needs and are scientifically validated. These methods are described in the chapter 3.2.1 starting on page 11.

2.2 Goal orientation

Goal orientation is a psychological term that describes the behavioural patterns individuals display in achievement situations that occur in such contexts as work life or studying. The basis of the theory are the individual differences in underlining motivation when people are setting their outwardly perceivable goals in the achievement contexts. Goal orientation can be seen manifesting itself as individuals "patterns of cognition-affect-behaviour that have profound effects on adaptive functioning", as defined by Dweck & Leggett (1988). From this description it can be seen that goal orientation is similar to emotion in being a complex phenomenon, that guides adaptive functioning.

Goal orientation as a whole has been theorized to be comprised of a number of dimensions. Number of dimensions differs between studies, but Kaplan & Maehr (2007) found that *mastery orientation* and *performance orientation* are present in most. Originally goal orientation was seen as one dimension, with performance and mastery orientations as its extremes. In performance orientation the driving motivation is the person's will to demonstrate competence. Failure in this can lead to avoidance of task. People with mastery orientation want to develop their competence and thus can more readily accept failure in a task and still feel they achieved something by learning about the matter. The results by Vandewalle (1997) prompted a further divide of performance orientation to two dimensions: performance-prove and performance-avoid. Elliot & McGregor (2001) defines that performance-prove orientation is shown by the individual seeking positive evaluation from others, while performance-avoid is shown by the individual trying to avoid receiving negative evaluation.

The differing orientations have been linked to person's concept of the self. Dweck & Leggett (1988) linked goal orientation to how people can either see their attributes as persistent trades, or attributes that will change according to effort spent in improving them. If for example one perceives their intelligence as a trade set to a certain level, then in achievement situations where the person estimates the challenge of the tasks to be too high for their own perceived intellectual level, this could lead to avoidance of the tasks to avoid embarrassment.

In performance orientation the driving motivation is the person's will to demonstrate competence, for example to get high grades. People with mastery orientation want to develop their competence and can more readily accept failure and still feel they achieved their goals if they learned something meaningful in the process.

In learning situations students with mastery orientation are better adapted for self-regulated learning and display positive affect and well-being (Kaplan & Maehr 2007). Kaplan & Maehr (2007) link performance-prove with both positive outcomes (for example persistence, which seems to be in conflict with other theories) and negative comes (for example low retention of knowledge). Performance-avoid is linked with avoidances of challenge and avoidance of seeking help (Urdan et al. 2002).

Kaplan & Maehr (2007) found in their review that self-report questionnaires are the instrument used by methods goal orientation. These questionnaires usually include a number of statements that cover the goal orientations included. The people

answering the questionnaires evaluate how well the statements describe themselves and report that using a numbering scale attached to the statements. The names and number of the goal categories used in the questionnaires differs, but mastery and performance goal orientation categories are present in all reviewed by Kaplan & Maehr (2007). The wording and number of statements differs between questionnaires. Of the available questionnaires, the goal orientation questionnaire by Button, Mathieu & Zajac (1996) was chosen for this thesis because it has been validated and used, and provided adequate measurement of the phenomenon.

3. RESEARCH QUESTIONS AND METHODS

Goal orientation and the effect of emotional design had on the students were the focus of this thesis and were tested in the study conducted. The research was focused by formulating two research questions. Research questions are presented in the first section of this chapter. The second chapter gives rationale for selecting the research methods used, and descriptions of the methods.

3.1 Research questions

Research question 1 How does the combined use of colour and human-like shaped visualizations affect students learning outcomes or emotive state?

Hypothesis. Students who use learning material with combined use of colour and human-like shapes will have stronger change in their emotions and have better learning outcomes.

General approach and analysis. Hypothesis for the research question 1 can be tested by between groups studies. Two separately studied variables are

i change in the emotional state before and after studying the online exercise material

ii differences in learning outcomes

iii perceived qualities of the learning material.

The setup calls for two variants of the same study material, one designed using standard design for the control group and other one for the treatment group designed with emotional design. If all other variables remain the same between the groups

as assumed, the differences in variables can be credibly accredited to the emotional design. Unpaired t-test can be used to compare 2 independent unpaired groups.

Research question 2 How do students differing goal orientations affect their learning outcomes or emotive state when using learning material designed with a combination of colour and human-like shaped visualizations?

Hypothesis. Students with predominant learning/mastery goal will benefit more from using emotional design material and have better learning outcomes and stronger change in their emotional states than the students with performance goal orientation, as they can be more inhibited by the possible extraneous processing required by the additional elements in material.

General approach and analysis Answer for research question 2 can be found by studying correlations between students' goal orientations and the effect studying the study material that has on their emotional state and learning outcomes. This can be achieved by applying a between groups study. Using two design variants of the same study material, one variant of standard design and the other one designed with emotional design gives a change for between groups comparison. Pearson product-moment correlation coefficient can be used to study the correlation between two variables. In this thesis here the two separate variable pairs are

i goal orientation and the change in emotional state

ii goal orientation and learning outcomes

3.2 Methods and questionnaires

In this section the methods that were used to measure emotional state, user experience and goal orientation are described. Also the prior programming experience questionnaire and the questionnaire from previous Aalto university study that were used in this study are described.

3.2.1 Methods used for measuring emotion and user experience

In this subsection the I-PANAS-SF and Attrakdiff 2 short methods are described.

3.2.2 I-PANAS-SF

I-PANAS-SF (The International Positive And Negative Affect Schedule Short Form) is a questionnaire by Thompson (2007). I-PANAS-SF is a method for measuring positive and negative affect. The method employs a questionnaire that lists 10 terms to describe emotional state. Short Form part of the name comes from the fact that the 20 items of the original PANAS have been reduced to 10, building on the work of (Crawford & Henry 2004). 5 of the items represent positive affect and 5 items the negative affect. The items in positive affect are: determined, attentive, alert, inspired and active. Items in the negative category are afraid, nervous, upset, ashamed and hostile.

Crawford & Henry (2004) found PANAS to be a valid and reliable in measuring positive and negative affect. They however take the position that the terms 'positive affect' and 'negative affect' can be replaced by terms 'positive activation' and 'negative activation', as the PANAS best measures activation of the affects. They also found that the several affects had considerable covariance and the amount of affects queried could be reduced from the 20, paving way for the I-PANAS-SF.

I-PANAS-SF is based on categorical emotion model. I-PANAS-SF is suitable for capturing participants self-reported impressions of their emotional states. In the study conducted this method was used to study students' emotional state before and after they had studied the online exercise material. The differences between the two states were used in analysis.

Appendix E shows the questionnaire as it was used in the study. Participants filled the questionnaire, rating each item as it applies to them using a numeric scale ranging from 1 ("Not at all") to 7 ("A lot").

The I-PANAS-SF was chosen for this study because of its brevity and the ability to capture students positive and negative affects and the effects emotional design might have in them. In the collected data there was no correlation between the positive and negative affects' changes, which can be seen in the scatter-plot presented in Figure 3.1. This means that the two affective changes can be viewed as separate phenomena, as the theory behind PANAS assumes.

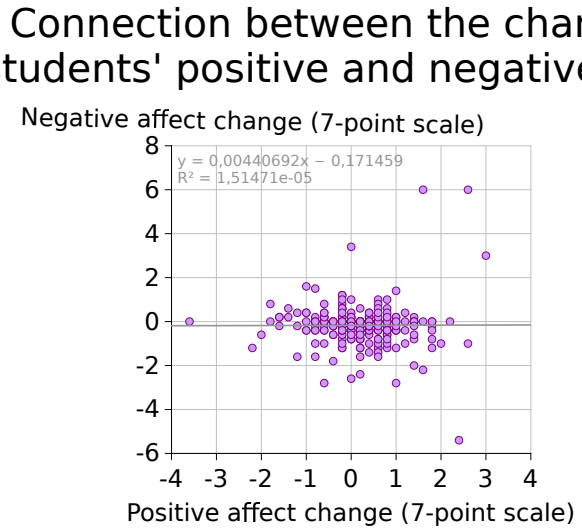

Figure 3.1 *Scatterplot of Positive and Negative affects' changes correlation. Whole sample.*

3.2.3 Attrakdiff 2 short

Attrakdiff 2 questionnaire by (Hassenzahl & Monk 2010) measures user experience offered by a product by making the users evaluate product's different qualities. User experience is defined as "person's perceptions and responses that result from the use or anticipated use of a product, system or service" in the definitions of (ISO 2010). In a survey of user experience professionals by Law, Roto, Hassenzahl, Vermeeren & Kort (2009) most popular of predefined definitions of user experience was "A consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.) the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)".

Attrakdiff 2 questionnaires use semantic differentials, pairs of polar opposite terms (for example Good - Bad) to represent each quality of the product. These semantic differentials form groups to measure the four dimensions of the products user experience: pragmatic quality, hedonic quality and overall appeal, of which hedonic quality is further divided to identification and stimulation dimensions.

Attrakdiff 2's practical quality covers the usability attributes of "effectiveness, efficiency, and satisfaction" as stated in (ISO 1998). Hedonic stimulation measures how much the product is felt to offer inspiration, be interesting, and offer oppor-

tunities for betterment of self. Result for hedonic identification reflects how much users feel the product shares their values and let's them express themselves. Overall appeal gives an estimation of the general impression product has made on the users. According to Hassenzahl & Monk (2010) users' evaluation of overall appeal is based on the pragmatic and hedonic qualities users experience.

Table 3.1 *The semantic differentials of Attrakdiff*

Measured quality	**1. polar opposite**	**2. polar opposite**
Pragmatic Quality	Confusing	Clearly Structured
	Unpredictable	Predictable
	Simple	Complicated
	Practical	Impractical
Hedonic Quality - Identification	Stylish	Tacky
	Cheap	Premium
Hedonic Quality - Stimulation	Dull	Captivating
	Creative	Unimaginative
Overall Appeal	Bad	Good
	Ugly	Beautiful

Attrakdiff 2 short (Hassenzahl & Monk 2010) questionnaire includes 10 semantic differential term pairs. Table 3.1 shows the semantic differentials and their grouping to dimensions. In the study for this thesis Attrakdiff 2 short questionnaire was used to study the qualities of the online exercise study materials and the material used in the course in other exercises and other learning activities.

Attrakdiff 2 short was used in this study because it was concise, but at the same time gave a wide view of the qualities of the learning material variants. Appendices B and F show Attrakdiff 2 short questionnaire used in the study, for before and after studying the online exercise material. Students filled the questionnaire by rating each item as it applies to them using a numeric scale ranging from 1 to 7 that was shown between the semantic differential word pairs.

3.3 Aalto questionnaire

To enable future comparisons between the material collected in this study and the previous Aalto University study by Haaranen, Ihantola, Sorva & Vihavainen (2015), the questionnaire used in Aalto study was included in this study. The questionnaire was used to collect information about the user experience of the online exercise material and student's learning outcomes. The user experience questionnaire is quite similar to Attrakdiff 2 short as it measures practical, hedonic and overall appeal of

the study material. But the questions used to measure user experience are close to "effectiveness, efficiency and satisfaction" qualities of usability (ISO 1998).

Table 3.2 *Text of the questions in Aalto study questionnaire with their types and options.*

Question ID	Question	Question type	Options
Q1	**EN** Weekly exercise 10.1: Based on what you read, describe what is meant by object-oriented programming. **FI** Viikkoharjoitustehtävä 10.1: Lukemasi perusteella, kerro mitä olio-ohjelmoinnilla tarkoitetaan.	Freeform text	
Q2	**EN** Could you have answered the weekly exercise 10.1 without you studied this weekly exercise? **FI** Olisitko osannut vastata viikkoharjoitustehtävään 10.1 ennen kuin kävit läpi tämän harjoituksen oppimateriaalin?	Multiple choice	Yes | No
Q3	**EN** Weekly exercise 10.2: What kind of objects would you use in a program, that keeps the records of a hotel's room bookings? Give an example of how these objects would communicate? **FI** Viikkoharjoitustehtävä 10.2: Minkälaisia olioita käyttäisit ohjelmassa, jonka tehtävänä olisi pitää kirjaa hotellin huonevarauksista? Anna yksi esimerkki siitä, miten nämä oliot keskustelevat keskenään?	Freeform text	
Q4	**EN** Could you have answered the weekly exercise 10.1 without you studied this weekly exercise? **FI** Olisitko osannut vastata viikkoharjoitustehtävään 10.2 ennen kuin kävit läpi tämän harjoituksen oppimateriaalin?	Multiple choice	Yes | No
Q5	**EN** How concentrated were you when you read the learning material? (1 - very concentrated, 5 not at all concentrated) **FI** Kuinka keskittyneesti luit oppimateriaalia? (1 - hyvin keskittyneesti, 5 - ei lainkaan keskittyneesti)	Multiple choice	Scale of 1 - 5
Q6	**EN** How comprehensible was the learning material? (1 - very comprehensible, 5 not at all comprehensible) **FI** Kuinka ymmärrettävää oppimateriaali oli? (1 - hyvin helposti ymmärrettävää, 5 - hyvin vaikeasti ymmärrettävää)	Multiple choice	Scale of 1 - 5
Q7	**EN** How pleasant was the learning material? (1 - very pleasant, 5 - not at all pleasant) **FI** Kuinka miellyttävää oppimateriaali oli? (1 - hyvin miellyttävää, 5 - ei lainkaan miellyttävää)	Multiple choice	Scale of 1 - 5
Q8	**EN** The illustration of the material helped me understand the study matter. (1 - completely agree, 5 - completely disagree) **FI** Materiaalin kuvitus auttoi ymmärtämään opittavaa asiaa. (1 - täysin samaa mieltä, 5 - täysin eri mieltä)	Multiple choice	Scale of 1 - 5
Q9	**EN** The illustration of the material was attractive. (1 - completely agree, 5 - completely disagree) **FI** Materiaalin kuvitus oli miellyttävää. (1 - täysin samaa mieltä, 5 - täysin eri mieltä)	Multiple choice	Scale of 1 - 5
Q10	**EN** General feedback about the material **FI** Vapaata palautetta materiaalista	Freeform text	

Table 3.2 shows the questions of the Aalto questionnaire. In the Question column of the table, the questions are given in their original Finnish language form (marked FI in the table) and as English translations (marked EN). Appendix G shows the

questionnaire as it was presented in the study to the students.

3.3.1 User experience

User experience of the online exercise material was done using questions about the concentration of the students, the level of comprehensibility and pleasantness of the material, how much the illustrations helped and how attractive they were. These questions have IDs Q5 - Q 9 in the Table 3.2. All the questions used a 5-point scale, where lower number meant higher level for the attribute.

3.3.2 Learning outcomes

The focus of this study is in the emotional aspect of the learning process, but Aalto questionnaire also included two questions that required students to apply the knowledge of object-oriented programming presented in the online exercise material. The weekly exercise questions measuring learning outcomes required students to write answers with their own words. These 2 question were accompanied with multiple choice questions asking the students, if they could have answered the learning outcome questions before studying the exercise material. Learning outcomes questions have IDs Q1 - Q 4 in the Table 3.2.

Comprehension of studied material, transfer or applying of the achieved knowledge to other problems areas, and the retention and recollection of accumulated knowledge are metrics that can be measured Um et al. (2012). Comprehension and transfer can be measured with these questions to a certain degree. The answers were evaluated on scale of 0 - 1, where a 0 means that the student's answers shows no comprehension and transfer, a 1 means that there were some right elements in the answer and a 2 indicates that the student demonstrates good transfer of knowledge. If measuring retention and recollection is to be done, it has to be measured with follow-up study that should involve the same participants as this study and questions that focus on the same topic.

3.4 Measuring goal orientation

Button et al. (1996) devised the questionnaire that divides goal orientation into two categories: performance goal orientation and learning goal orientation. In the

questionnaire each category consists of 8 statements, 16 in all. The goal orientation statements in their original English are shown in Table 3.3. The strength of goal orientations can then be deduced for the two goal orientation categories.

Table 3.3 *The statements in goal orientation questionnaire by Button et al. (1996) that was used in the study.*

Goal orientation	Goal orientation statement
Performance goal orientation	I prefer to do things that I can do well rather than things that I do poorly.
Performance goal orientation	I'm happiest at work when I perform tasks on which I know that I won?t make any errors.
Performance goal orientation	The things I enjoy the most are the things I do the best.
Performance goal orientation	The opinions others have about how well I can do certain things are important to me.
Performance goal orientation	I feel smart when I do something without making any mistakes.
Performance goal orientation	I like to be fairly confident that I can successfully perform a task before I attempt it.
Performance goal orientation	I like to work on tasks that I have done well on in the past.
Performance goal orientation	I feel smart when I can do something better than most other people.
Learning goal orientation	The opportunity to do challenging work is important to me.
Learning goal orientation	When I fail to complete a difficult task, I plan to try harder the next time I work on it.
Learning goal orientation	I prefer to work on tasks that force me to learn new things.
Learning goal orientation	The opportunity to learn new things is important to me.
Learning goal orientation	I do my best when I'm working on a fairly difficult task.
Learning goal orientation	I try hard to improve on my past performance.
Learning goal orientation	The opportunity to extend the range of my abilities is important to me.
Learning goal orientation	When I have difficulty solving a problem, I enjoy trying different approaches to see which one will work.

Button's goal orientation questionnaire was chosen for this study because it gives an accurate knowledge of the students performance and mastery goal orientations. Appendix C shows the goal orientation questionnaire in the form it was used in the study. Students filled the questionnaire by rating each item as it applies to them using a numeric scale ranging from 1 ("Strongly disagree") to 7 ("Strongly agree") that was shown under the statements.

These results were processed using statistical methods to find correlation between goal orientation and emotional state or learning outcomes.

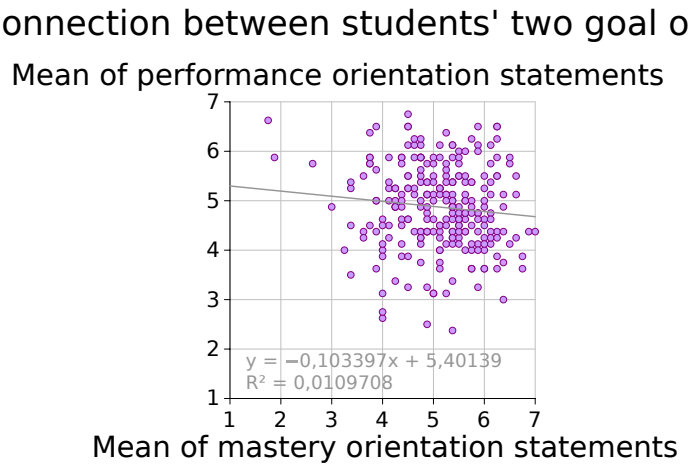

Figure 3.2 *Scatterplot of students mastery and performance goal orientations.*

To explore a possible correlation between the strength of mastery and performance tendencies, a scatter plot was drawn. The scatter plot can be seen in Figure 3.2 and it shows that the two goal orientation tendencies had no correlation in this sample.

3.5 Prior programming experience questionnaire

Participant programming knowledge and experience were collected with a prior programming experience questionnaire. The questions presented to them are shown in Table 3.4. Appendix D shows the questionnaire as it was used in the study.

Table 3.4 *The questions and their options in questionnaire about previous programming experience. In the Multiple choice-column different choices are separated by "|"-signs)*

Question	Multiple choice
I have programmed before this course	Daily | Weekly | Monthly | Less often | Not at all
I have done object-oriented programming before this course	Daily | Weekly | Monthly | Less often | Not at all
I program on my free time	Daily | Weekly | Monthly | Less often | Not at all
I read programming related material or web pages on my free time	Daily | Weekly | Monthly | Less often | Not at all
I can name programming languages	0 | 1| 2 - 3 | 4 or more
I can name programming styles and programming paradigms	0 | 1| 2 - 3 | 4 or more

3.6 Study setup

In this section the context, study material, participants and procedure of the conducted study are described. In the Subsection 3.7 the procedure that was used in described in the order the students performed it.

3.6.1 Context

Goal orientation and emotions were studied in the context of university computer science education. The platform used for the study was an elementary programming course at Tampere University of Technology. The study was conducted as one of the course's weekly online exercises, with questionnaires for the students to answer before and after they had studied the online exercise material. The online exercise was open for students during the December of 2015.

3.6.2 Study materials used in the online exercise

The subject of the online exercise material was object-oriented programming and it consisted of 21 web pages with text and images and navigation links to next

and previous web page. All the material and questionnaires were in the Finnish language. The online exercise material and parts of the questionnaires were modified from original material previously created and used at Aalto University in a study by Haaranen et al. (2015). This original material had two variants, a traditional variant with greyscale abstract visualizations and a emotional design variant where the elements in visualizations were changed to human-like figures. In designing the study conducted for this thesis the traditional variant of the original material with grayscale abstract visualizations was used as the *traditional material* variant of the online exercise material. The *emotional design material* variant of the online exercise material for the study was designed by adding colour to human-like images in the original material. The text in all the variants of the online exercise materials was identical. Figure 3.3 shows the 10th page of the exercise as presented to students in emotional design material variant group and figure 3.4 the traditional material variant.

3.6.3 Participants

Participant were students in the elementary course. The online exercise, as other weekly exercises, was a voluntary part of the course. The demographic information about the student sample was collected with the demographic questionnaire. Questionnaire had questions about students

- Gender
- Age
- Starting year of studies at Tampere University of Technology
- Study major
- Number of academic credit points.

In the gender question the students chose one option from 'Women', 'Men' and 'Other', but no-one chose 'Other' in the final sample. As the Table 3.5 shows, the division of different genders to 2 online study material groups was uneven. Women made up roughly 1/3 of the whole sample, but were only 1/5 of the emotional design variant group and almost half of the traditional variant group.

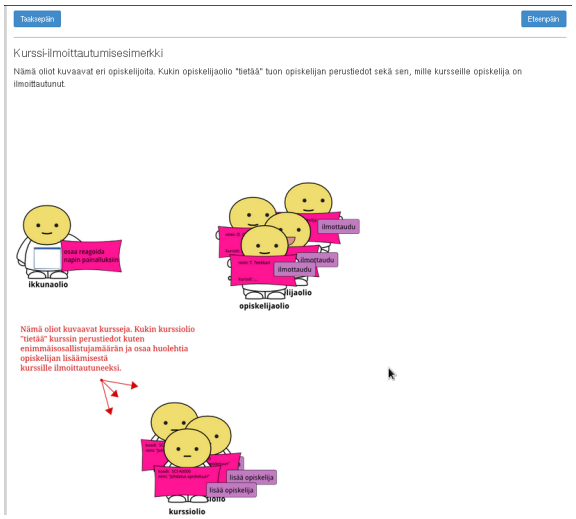

Figure 3.3 *Emotional design variant of the exercise online material, picturing the last web page*

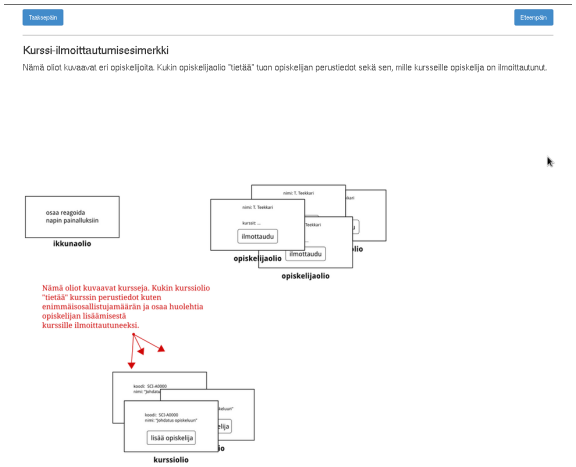

Figure 3.4 *Traditional variant of the exercise online material, picturing the 10th web page*

As can be seen from Figure 3.5, in the studied group the participants were 18 - 51 years old (mean 24, median 21 and standard deviation 4.0), with 4 entries missing age information. They had started their studies at Tampere University of Technology between 1997 and 2015 (mean 2013, median 2014, standard deviation 2.24), with four entries missing this information. They had grade averages from 0.6 to 5 (mean 3.1, median 3, standard deviation 0.85), with 21 entries either missing this information or had been marked 0, which was replaced be an empty value in data.

Table 3.5 *Gender in the whole sample, and in traditional (marked TRAD in the table) and emotional design (EMO) variant groups.*

	ALL (n)	**ALL %**	**EMO (n)**	**EMO %**	**TRAD (n)**	**TRAD %**
Men	165	65.5%	100	76.9%	65	53.3%
Women	87	34.5%	30	23.1%	57	46.7%
Total	252	100.0%	130	100.0%	122	100.0%

Collected study points ranged between 0 - 277 study points (mean 75,0, median 66, standard deviation 55,7) with 4 entries missing this data. Students were studying various different majors at Tampere University of Technology, with 2 students also from Open University. 4 entries were missing student's major data.

Participants had some elementary programming knowledge with 103 reporting being able to name 4 or more programming languages, 129 could name 2 or 3, 14 could name and 9 couldn't name any. Answers to a more in depth question about the amount of known programming paradigms and styles showed that the knowledge students had was mostly in line with the early state on studies, as shown by starting year median 2014. 159 reported that couldn't name any programming paradigms or styles, 55 knew 1, 39 students knew 2 or 3, and 2 students knew 4 or more. It can be assumed that the number of programming paradigms and styles in use is less than the number of programming languages, but it can be further assumed that an experienced software professional would know at least a few paradigms or styles. The subject of the online exercise material, object-oriented programming, is one of the paradigms and if the students would have known this, they could have name at least one. This is supported by the answers to the programming experience questions. 141 hadn't programmed before, 99 had programmed less frequently than monthly and 15 programmed monthly or more frequently. When narrowing programming to object-oriented programming, 201 students hadn't programmed at all, 48 less frequently than monthly and 6 programmed monthly or more frequently. 185 didn't program in their leisure time, 44 less frequently than monthly and 26 students programmed in their leisure time more frequently than monthly. To question if they read any programming related literature or web pages in their leisure time 160 students answered no, 61 reported reading such material less frequently than monthly and 34 read programming related material more frequently than monthly. All these answers can be interpreted to show that the sample has about 26 student programmers with some experience, about 50 somewhat knowledgeable, but inexperienced programmers and the rest about 200 of the of the 255 students with

little previous knowledge or experience in programming. This would mean that the object-oriented programming material would be new to most of the students.

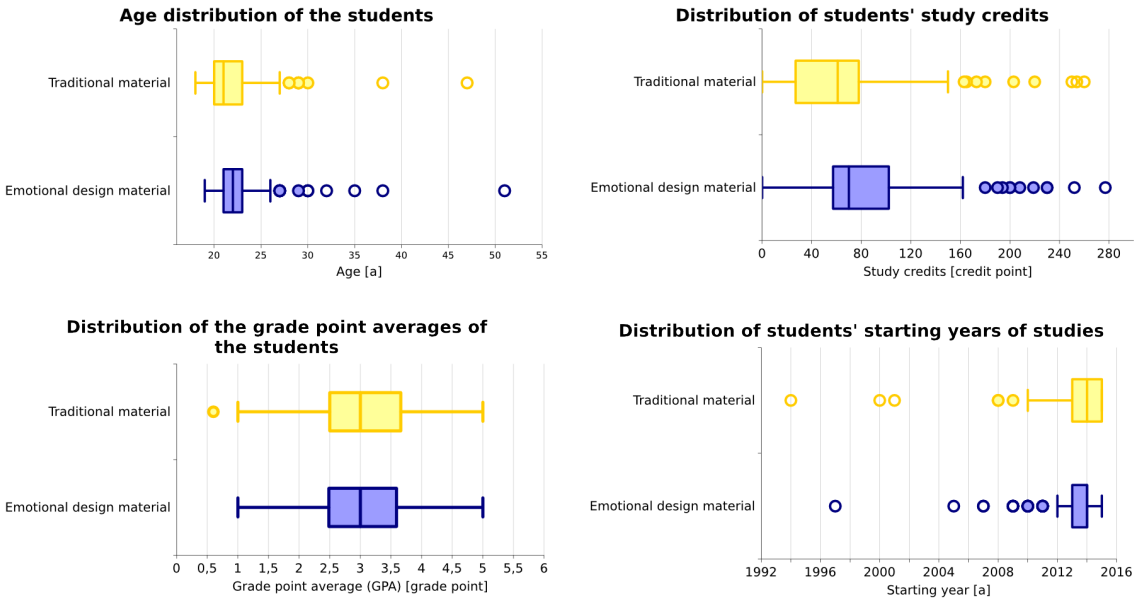

Figure 3.5 *Age (top left), study credits (top right), GPA (lower left) and starting year (lower right) information for the emotional design and traditional exercise material variant groups.*

3.7 Procedure

Figure 3.6 shows the study by displaying the progress of the study including the questionnaires and studying the material. Following paragraphs give closer descriptions of the stages in order that students encountered them. The questionnaires are included in the appendices.

3.7.1 Partition to two groups

The students were divided into two groups based on their answers in the prior programming experience questionnaire. The groups were given different variants of the online exercise to study. The aim was to distribute students evenly to two groups, so that both would have equal amount of students from all programming experience levels. Even distribution of students with different goal orientations to both material variant groups was assumed to happen automatically, because of the assumed equal presentation of goal orientations in all programming experience levels.

123 participants were placed in the traditional material variant control group and 132 in the emotional design material variant treatment group. The discrepancy in group sizes is explained by the need to drop certain participants' entries from the data because they had entered of insufficient or clearly invalid data, or the database entries for their answers were empty.

3.7.2 Student number prompt

Students were given a web link to the online exercise. On the first web page the students were told about the weekly exercise about to begin in and the study in which they were about participate. At the end of the web page students wrote their student numbers. Student numbers were used to identify students in the data.

3.7.3 Demographic and study information questionnaire

On the second web page students answered a questionnaire collecting their demographic and academic data. Appendix A shows the questionnaire as it was used.

3.7.4 Prior course material Attrakdiff 2 short questionnaire

Attrakdiff 2 short questionnaire collected information about students' feelings towards course material used prior to study. This information was used to find if the students had strong views about the material that has been previously used in the course, which could influence the way they experience the online exercise material. 7 point numeric scale was used.

Appendix B shows the questionnaire as it was used. At the top of the questionnaire there was instructions for the students in Finnish. In the instruction the term *semantic differential* was replaced with term *word pair*, as the original term might have confused students. The instructions, when freely translated to English, read:

> Read the following instructions carefully.
>
> With this questionnaire you can evaluate the learning materials used in this course.

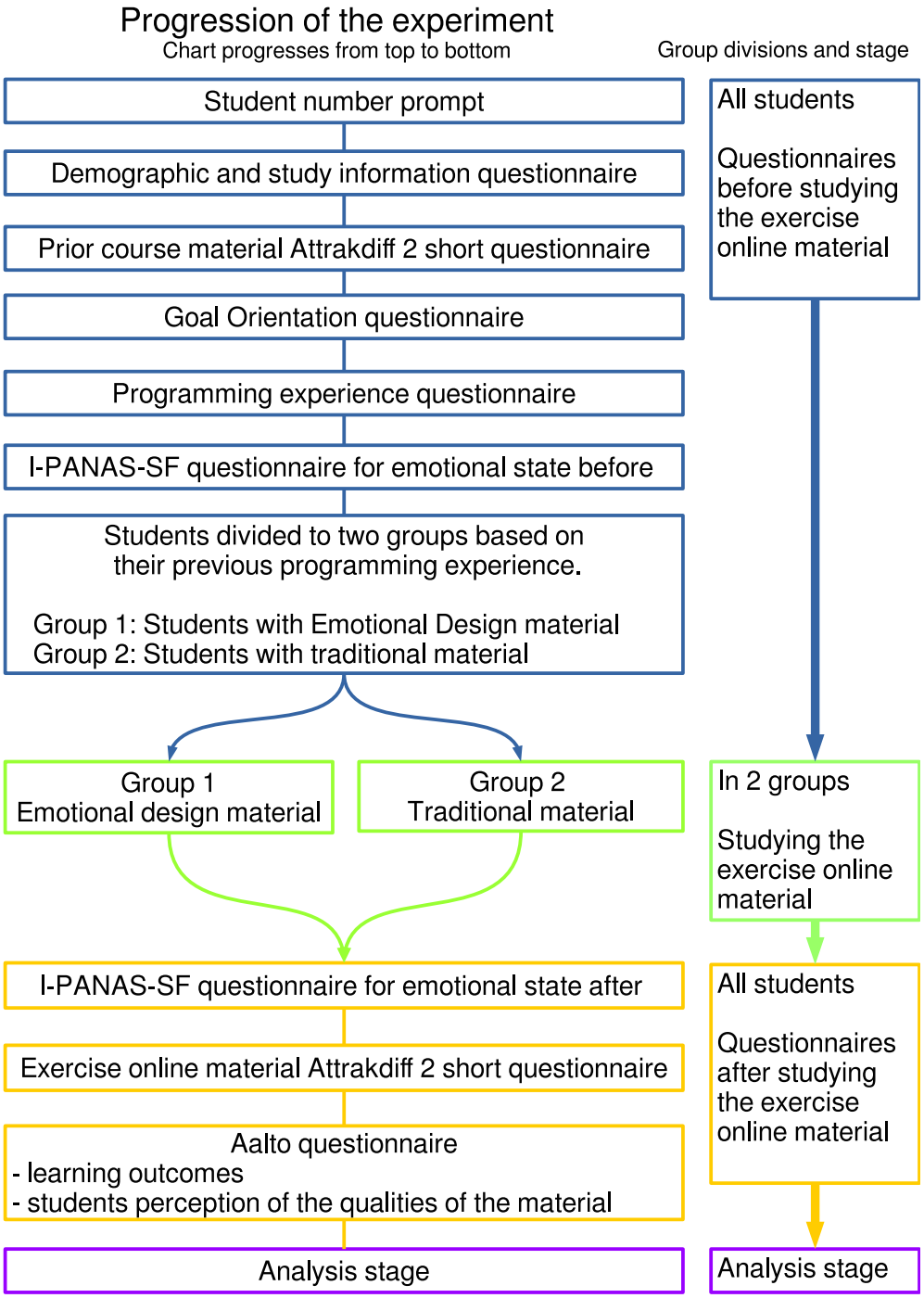

Figure 3.6 *Stages of the study and the methods used to collect data from students.*

The questionnaire is made of pairs of words, which enable you to evaluate the learning materials used in the course. Each pair of words is composed

> of words that are representative of extremes of a scale. The scale from 1 to 7 between the pair of words gives you a change to express the strength of your experience of the attribute of represented by the pair of words. For example, if for the word pair Confusing - Clearly Structured you choose the value 5, this indicates that you feel that the course material as a whole was mostly clearly structured, but that some improvements could be made.
>
> Don't use up time thinking about the word pairs. Give your spontaneous answer. You might feel, that all word pair do not describe the course material adequately. Even in such situations, give your answer. Keep in mind, that there is no right or wrong answers. Your opinion is what counts!
>
> **Use the word pairs below and choose values from the scale, that in your opinion best describe the course material. Remember to choose a value for each word pair!**

Using these instructions, the students then chose the values for the 10 word pairs. These word pairs were presented in Table 3.1 on page 14.

3.7.5 Goal orientation questionnaire

Button's goal orientation questionnaire with 16 statements and 7 point numeric scale, with end points named (Strongly agree - Strongly disagree). Appendix C shows the questionnaire as it was used.

The students were given the following instructions at the top of the questionnaire (translated from Finnish):

> This questionnaire surveys your learning related goal orientation. The questionnaire consists of 16 statements. For each statement, first read the statement and the choose a number that best fits how the statement applies to you. Values are on the scale from 1 (Strongly disagree) to 7 (Strongly agree).

3.7.6 Programming experience questionnaire

This questionnaire had questions about the students' programming experience, interest in programming in general and object oriented programming in particular. These answers were used to classify the students into different experience levels as programmers. Appendix D shows the questionnaire as it was used. The students were given a sentence's worth of instruction at the top of the questionnaire: *Describe your programming experience.*

3.7.7 I-PANAS-SF questionnaire for emotional state before

Students emotional state prior to studying the exercise online material was measured by their answers to I-PANAS-SF-questionnaire. 7 point numeric scale was used, with named endpoints (Not at all - A lot). Appendix E shows the questionnaire as it was used.

The questionnaire started with short instructions (translated from Finnish):

> This questionnaire is used to survey your current emotional state. Questionnaire consists of ten different emotions, the strength of experiencing of which you must evaluate using a scale from 1 (Not at all) to 7 (Very strongly).
>
> Question: When you think of yourself and about what you feel at this moment, to what extent do you feel that you are:

Then the students were presented with the emotions of I-PANAS-SF as shown in subsection 3.2.2 on page 12. 7-point numeric scales were attached to each of emotions.

3.7.8 Studying the material

Upon reaching this stage the students studied the online exercise material at their own pace. The two material variant groups were shown appropriate materials. The material presented elementary information about object-oriented programming. The time the student entered a page in the material and the time they moved on from it was recorded to database. Students could navigate freely backwards and forwards between the pages in the material.

3.7.9 I-PANAS-SF questionnaire for emotional state after

Students were presented the questionnaire after they had finished studying the material and moved forward from the last web page of the online exercise material. Same 7 point numeric scale was used. The questionnaire was identical to I-PANAS-SF questionnaire for emotional state before, and the English translation for the questionnaires contents is shown there. Appendix E shows the questionnaire as it was used.

3.7.10 Exercise online material Attrakdiff 2 short questionnaire

Students sentiments about the online exercise material was collected with Attrakdiff 2 Short Form questionnaire. 7 point Likert-scale was used, identical to the previous Attrakdiff 2 questionnaire. Appendix F shows the questionnaire as it was used.

As the focus of this questionnaire was the online exercise material the students had just used, the instructions had to be modified from the Attrakdiff 2 short questionnaire used to measure the student's views on the course material. But otherwise than the appropriate instructions, the questionnaire was identical. The modified part of instructions given read (translated from Finnish):

> ...
> With this questionnaire you can evaluate the learning materials for the practice you just completed.
>
> The questionnaire is made of pairs of words, which enable you to evaluate the learning materials for the practice you just completed. ...

3.7.11 Aalto questionnaire

In this last questionnaire of the study the students answered two questions that measured their learning outcomes (Weekly questions 10.1 and 10.2 in Table 3.2). The questionnaire also measured students' perception of the qualities of online exercise material. Appendix G shows the questionnaire as it was used.

3.8 The collected data

The users were identified in the data by their student numbers. Of the about 400 students on the course, 274 had some entries in the data. There were 274 unique student numbers recorded in the first questionnaire, and 259 in the last. This decline in questionnaire answers shows that some of students started the questionnaires, but for some reason left the online exercise uncompleted.

Some answers were not complete, were blank or were incorrectly saved to the database, which made them unusable. This made going through the data entries and deciding what answers could be used necessary. This process reduced the number of participants in data studied to 255.

4. RESULTS

In this chapter the results from the questionnaires, and the calculated results are described and mapped to the research questions. The independent and dependent variables are shown in Section 4.1. Results pertaining to Research question 1 (How does the combined use of colour and human-like shaped visualizations affect students' learning outcomes or emotive state?) are presented under Section 4.2, while results relevant to the Research question 2 (How do students' differing goal orientations affect their learning outcomes or emotive state when using learning material designed with a combination of colour and human-like shaped visualizations?) are given under Section 4.3.

4.1 Variables in the study

The questionnaires for the independent variables were placed before the online exercise. The independent variables are shown in the Table 4.1. The independent variables are demographic variables (age, gender, study information), goal orientation, emotional state before the exercise, and programming experience.

Table 4.1 *Independent variables in the study.*

Independent variable
demographic information
exercise material variant
goal orientation
emotional state before the exercise
programming experience

The variables that were hypothesized or were known to be dependent on other variables are shown in the Table 4.2. The required questionnaires for these variables were in the study after the exercise material.

Exercise material variant group was decided based on the programming experience, because the students that had plentiful previous programming experience would

Table 4.2 *Dependent variables in the study.*

Dependent variable
learning outcomes
change in emotional state
experienced qualities of the learning material

likely just skip the elementary exercise material all together and would still have to answer the questionnaires as they would have studied the exercise material. Learning outcomes were hypothesized to be dependant on goal orientation and the exercise material variant, this relationship is studied in this chapter. Change in emotional state was presumed to have a correlation with the exercise material variant the student used, as was the experienced qualities of the learning materials.

When the relations between two material variant groups in regards to demographic information was calculated, it was found out that groups significantly differed in the starting year and study points, but were similar in gender distribution and grade point average. Relationship between gender and material variant group was calculated using Chi-Squared test, while the relationship between material variant group and age, grade point average, starting year of studies, and study points were calculated using unpaired t-tests.

For starting year there was a significant difference between the emotional design material variant (M=2012.923, SD=2.267) and traditional material variant (M=2013.475, SD=2.196) groups; t(248)=-1.952, p=0.052. This means that the students on the emotional design material group had on average started their studies earlier. For the study points there was significant difference between the emotional design material (M=84.785, SD=54.860) and traditional material (M=64.561, SD=54.924) groups; t(249)=2.917, p=0.004. This means that the students in emotional design had accumulated more study points. A Pearson product-moment correlation coefficient was computed to assess the relationship between them. There was a strong negative correlation between the starting year and the study points, r=-0.644. This means that the students who have started their studies earlier have accumulated more study points.

When previous programming questionnaires were analysed for differences between material variant groups, the categorical selections in the six questions made using Chi-Squared test necessary. The p-values from Chi-Squared calculations were all over the significance level. This means that there was no relationship between the

material variant and programming experience.

4.2 Effects of the used online exercise material variant on students

In this section the effect the exercise material variant the student's used is described. More precisely, the changes in students' emotional states, learning outcomes, and the perceived qualities of the materials were tested.

4.2.1 Material variant and change in emotional state

Students' emotional states were queried using I-PANAS-SF questionnaire at 2 points, once before and once after they had studied the online exercise material. Using the answers, a numeric average for the 5 items in positive affect was calculated to represent the positive affect. Same was done for negative affect using the 5 items in that category. Changes in emotional state were calculated within the affect categories by deducting the numeric values representing student's emotional state before the online exercise from the values representing the emotional states after. Effects of the exercise material variant on students' positive and negative affects and shown next.

Material variant group's relation to changes in positive affect

Box plot of the variant groups shown in Figure 4.1 shows the changes in the positive affects of both material variant groups, the emotional design material variant group and traditional material variant group.

An independent-samples t-test was conducted to compare change in the positive affect and traditional material variant conditions. There was no significant difference in scores for emotional design material variant (M=0.176, SD=0.866) and traditional material variant (M=0.221, SD=0.823) conditions; t (253) = -0.428, p=0.669.

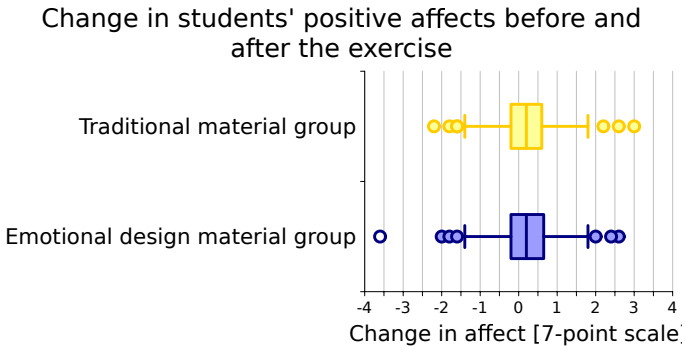

Figure 4.1 *Change in positive affect of the students in the exercise material variant groups.*

Material variant group's relation to changes in negative affect

The box plot of changes in students' negative affects is shown in Figure 4.2, displaying the emotional design material variant group and traditional material variant group.

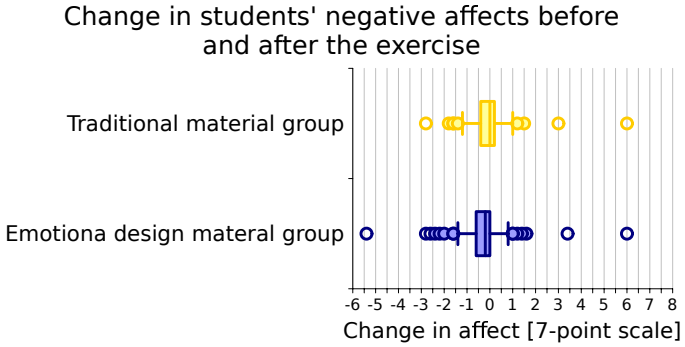

Figure 4.2 *Change in negative affect in exercise variant groups.*

An independent-samples t-test was conducted to compare change in the negative affect and the two material variant conditions. There was a significant difference in scores for emotional design material variant (M=-0.3, SD=1.045) and traditional material variant (M=-0.032, SD=0.831) conditions; t (253) = -2.258, p=0.019. The students studying with emotional design material variant experienced a more pronounced lessening in their negative affects than those using the traditional material.

4.2.2 Material variant and learning outcomes

The distribution of total points that students received for the graded questions is shown in Figure 4.3. These were questions with IDs Q1 and Q3 in the Aalto

questionnaire about object-oriented programming. An independent-samples t-test was conducted to compare change in the negative affect and traditional material variant conditions. There was a significant difference in scores for emotional design material variant (M=1.516, SD=0.611) and traditional material variant (M=1.336, SD=0.598) groups; t (252) = 2.358, p=0.025. Students in emotional design material group received higher score for their answers.

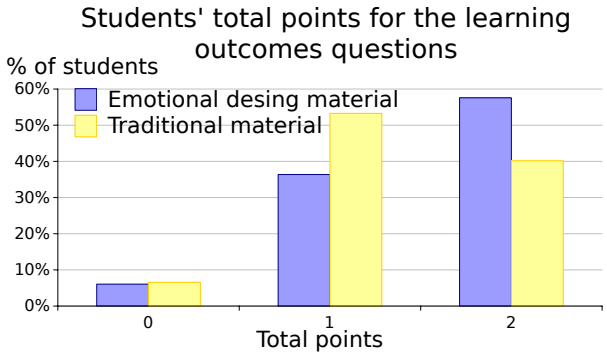

Figure 4.3 *Distribution of the total points given to students for the weekly exercise questions in the Aalto questionnaire.*

The questions of Aalto questionnaire with question IDs Q5 - Q9 were analysed using independent-samples t-test, as they pertained to aspects of learning material. In Q9 about how appealing the illustrations were, there is a significant difference between the emotional design material group (M=2.02, SD=1.02) and traditional material variant group (M=2.3, SD=0.96); t(251) = -2.313, p=0.002. This means that the students using the emotional design material found the material more appealing. For questions Q5-Q8 there was no significant difference between the two groups.

4.2.3 Material variant and perceived qualities of the materials

The qualities of the online exercise material was queried from the students using Attrakdiff 2 short questionnaire. Students answers for Pragmatic quality are given in Figure 4.4, in Figure 4.5 for Hedonic quality - Stimulation, in Figure 4.6 for Hedonic quality - Identification, and in Figure 4.7 for Overall appeal.

These measured qualities of Attrakdiff 2 short that are listed in Table 3.1 were tested with independent-samples t-tests. In Hedonic quality - Stimulation there was significant difference between the results of the emotional design material variant (M=4.943, SD=1.183) and the traditional material variant (M=4.63, 1.063) groups;

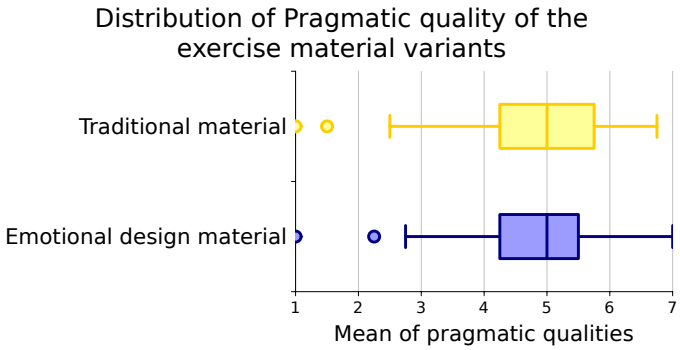

Figure 4.4 *Pragmatic attributes' values for the online exercise material.*

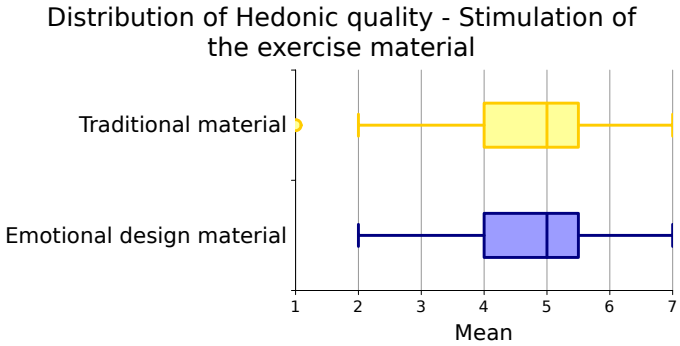

Figure 4.5 *Distribution of Hedonic quality - Stimulation attributes' values for the online exercise material.*

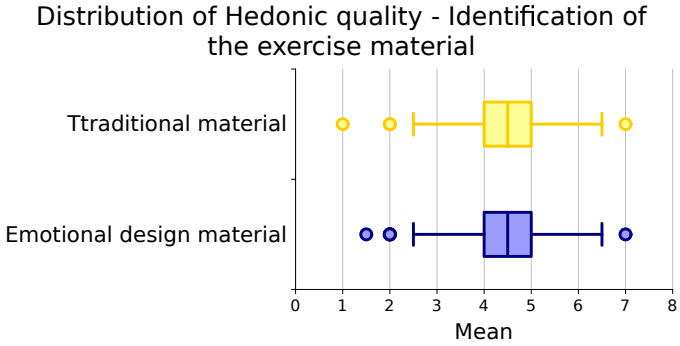

Figure 4.6 *Distribution of Hedonic quality - Identification attributes' values for the online exercise material.*

t(253) = 2.217, p=0.028. This results means that the students in emotional design material variant found that the material gave them offered them more inspiration and opportunities for self-improvement. The results for Pragmatic quality, Hedonic quality - Identification and Overall Appeal results did not differ between groups to significant degree.

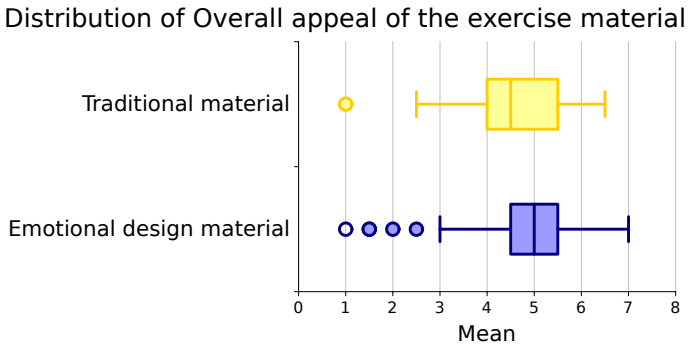

Figure 4.7 *Distribution of Overall appeal attributes' values for the online exercise material.*

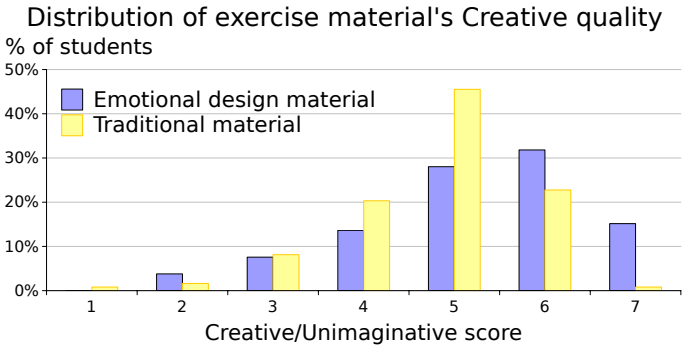

Figure 4.8 *Distribution of Creative attribute's values for the online exercise material.*

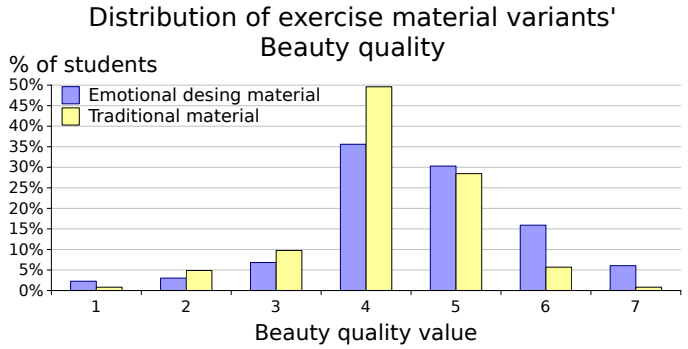

Figure 4.9 *Distribution of Beauty attribute's values for the online exercise material.*

When the Attrakdiff 2 short's 10 semantic differentials were separately tested using unpaired t-tests, Creative-Unimaginative and Ugly-Beautiful had significant differences between the two material variant groups. Figure 4.8 shows the distribution on values between groups in Creative-Unimaginative while Figure 4.9 shows these for Ugly-Beautiful. Creative-Unimaginative semantic differential values were significantly different between the emotional design material variant (M=5.220, SD=1.292) and traditional material variant (M=4.797, SD=1.016) groups; $t(253) = 2.892$,

p=0.004. For the Ugly-Beautiful semantic differential there was a significant difference for emotional design material variant (M=4.606, SD=1.234) and traditional material variant (M=4.203, SD=0.958) groups; t(253) = 2.897, p=0.004. These results mean that students in the emotional design material group found the material more creative and beautiful than those in traditional material group.

4.3 Effects of student's goal orientation

Students' answers in the goal orientation questionnaire were used to calculate means for their mastery and performance goal orientations. Distribution for the students' mastery goal orientations can be seen in Figure 4.10 and the distribution of performance goal orientations in Figure 4.11. When unpaired t-tests were used to calculate the differences between emotional design material variant and traditional material variant, there was no difference between the two groups, the goal orientations were equally distributed between the groups.

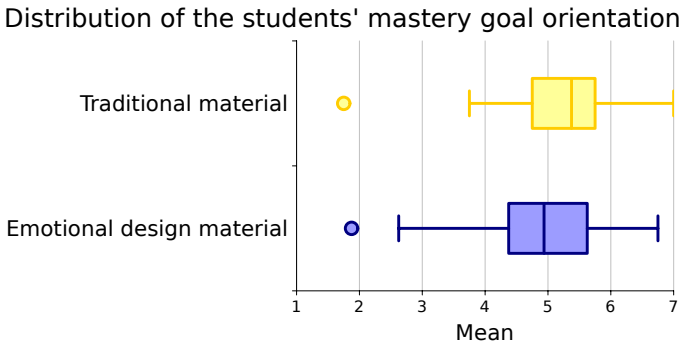

Figure 4.10 *Distributions of students' mastery goal orientations' mean values.*

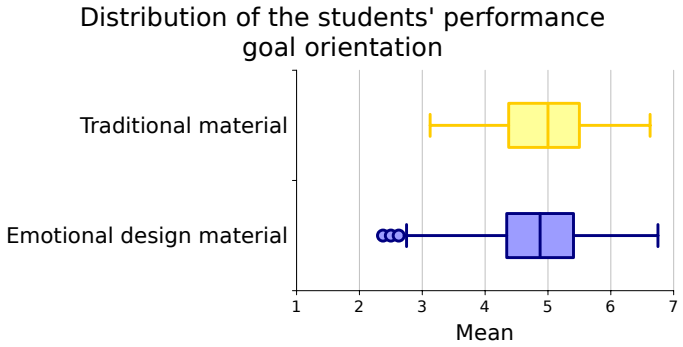

Figure 4.11 *Distributions of students' mastery goal orientations' mean values.*

Goal orientation's correlation was calculated with the change in emotional state and

learning outcomes. The correlations were calculated within the exercise material variant groups, to limit the possible effect material variant had on the results.

4.3.1 Goal orientation's correlation with the change in emotional state

To find the possible correlations between the goal orientation and the changes in students' affect, several variables had to be considered when calculating Pearson correlations for affect changes and goal orientations. These variables included the different variants of the study material groups were using, changes in the groups' negative and positive affects, and mastery and performance goal orientations. Pearson correlation was calculated between two variables. This led to 8 variable pairings in correlation calculations. The pairings are shown in Table 4.3.

Table 4.3 *Pearson correlation pairings. Emo. = the emotional design material group, Trad. = traditional material group.*

Pairing	1st variable - Goal orientation	2nd variable - Affect change
Pairing No. 1	Mastery orientation - Emo.	Positive affect change - Emo.
Pairing No. 2	Mastery orientation - Emo.	Negative affect change - Emo.
Pairing No. 3	Mastery orientation - Trad.	Positive affect change - Trad.
Pairing No. 4	Mastery orientation - Trad.	Negative affect change - Trad.
Pairing No. 5	Performance orientation - Emo.	Positive affect change - Emo.
Pairing No. 6	Performance orientation - Emo.	Negative affect change - Emo.
Pairing No. 7	Performance orientation - Trad.	Positive affect change - Trad.
Pairing No. 8	Performance orientation - Trad.	Negative affect change - Trad

The goal orientation and changes in affects were calculated within a study material variant student groups, so that data of students in emotional design and traditional material groups were calculated separately. This was done to eliminate the possible effect of the exercise material variant.

Goal orientation's correlation with the change in positive affect

Table 4.4 shows the variable pairings of goal orientation and positive affect change within a material variant groups. Last column shows the Pearson product-moment correlation coefficient between the two variables on the row.

All the numeric values for Pearson product-moment correlation coefficients are below the threshold of indicating correlation between the variables. So, there is no

Table 4.4 *Pearson product-moment correlation coefficient r for pairings of goal orientations and positive affect changes. Emo. = the emotional design material group, Trad. = traditional material group.*

	1st variable - Goal orientation	2nd variable - Affect change	Pearson coefficient r between variables
Pairing No. 1	Mastery orientation - Emo.	Positive affect change - Emo.	-0.089
Pairing No. 3	Mastery orientation - Trad.	Positive affect change - Trad.	0.058
Pairing No. 5	Performance orientation - Emo.	Positive affect change - Emo.	0.076
Pairing No. 7	Performance orientation - Trad.	Positive affect change - Trad.	-0.094

correlation between goal orientation and change in positive affect within material variant groups.

Goal orientation's correlation with the change in negative affect

Table 4.5 shows the variable pairings of goal orientation and negative affect change within a material variant groups. Last column shows the Pearson product-moment correlation coefficient between the two variables in the pairing.

Table 4.5 *Pearson product-moment correlation coefficient r for pairings of goal orientations and negative affect changes. Emo. = the emotional design material group, Trad. = traditional material group.*

	1st variable - Goal orientation	2nd variable - Affect change	Pearson coefficient r between variables
Pairing No. 2	Mastery orientation - Emo.	Negative affect change - Emo.	-0.023
Pairing No. 4	Mastery orientation - Trad.	Negative affect change - Trad.	-0.034
Pairing No. 6	Performance orientation - Emo.	Negative affect change - Emo.	-0.11
Pairing No. 8	Performance orientation - Trad.	Negative affect change - Trad.	0.037

Numeric values of the Pearson product-moment correlation coefficients are below the threshold of indicating correlation between the variables.There was no correlation between goal orientation and change in negative affect within material variant groups in the study data.

4.3.2 Goal orientation's correlation with the learning outcomes

A Pearson product-moment correlation coefficient was computed to assess the relationship between the goal orientation and learning outcomes of the students within exercise material variant group.

Table 4.6 shows the correlation for emotional design material variant group. Correlation values for both goal orientations are below the threshold for indicating correlation, mastery goal orientation r=0.111 and performance goal orientation r=0.061.

Table 4.6 *Pearson product-moment correlation coefficient for points for learning outcome questions of Aalto university study questionnaire. Emotional design material variant group.*

	Correlation with points for exercise
Mastery goal orientation	0.111
Performance goal orientation	0.061

Table 4.7 *Pearson product-moment correlation coefficient for points for learning outcome questions of Aalto university study questionnaire. Traditional material variant group.*

	Correlation with points for exercise
Mastery goal orientation	0.069
Performance goal orientation	-0.123

Correlations for traditional material variant group are shown in 4.7. Here again goal orientations have no correlation with the learning outcomes, mastery goal orientation r=0.069 and performance goal orientation r=-0.123.

5. DISCUSSION AND CONCLUSIONS

This thesis set out to study the effects of applying emotional design to modify learning materials used in the context of programming education, and the effects the students' goal orientations. In this chapter are given a critical discussion of the results, evaluation of the conducted study, and based on these some lines are proposed for future research. Conclusions are presented at the end of the section of their relevant research questions.

Study measured three variables: changes in student's in students' emotional states, their learning outcomes and the qualities of the leaning as experienced by the students. The discussion is partitioned under research questions and further under them using these variables.

5.1 Effects of emotional design material

The first research question of the study that focused on the effects of the emotional design on students emotions, learning outcomes and the experienced qualities of the learning material variants. The subject matter that was covered can be placed in the context of previous research, see Introduction section 1.

5.1.1 Change in emotional state

I-PANAS-SF method, that was used to measure the change in students' emotional states, provides two dimensions for measuring emotion: positive affect and negative affect. The results for these two affects are interpreted separately.

The study found a connection between the change in students' negative affects and the learning material they were using. The difference was calculated using an unpaired t-test. The change in negative affect was more pronounced in group using

emotional design material than for the group using traditional material variant. This can be interpreted to mean that the application of colour and human-like figures led to greater reduction in negative affects (afraid, nervous, upset, ashamed, hostile). So the students would get benefits from using the learning materials from reduce negative affect. Even though the results for the drop in negative affects are statistically significant, there are a few problematic aspects in the data. First of all, the difference in the numeric value of the means of the changes in negative affects is close to 0 for both groups, which indicates that the students did not actually feel that much of a change in their negative affects, when the variable considered was the exercise material variant used. There were several also outliers in the data. Outliers were in both material variant groups, but these indicate that for some students the change in their emotional states was much stronger to either side.

When we look at the change in students' positive affects (determined, attentive, alert, inspired, active) there was no difference between the two groups. The students positive affects rose at an equal rate, which could be interpreted to mean that the emotional responses the use of colours and human-like shapes in the emotional design exercise material variant did not give students additional help when compared to the traditional material variant.

These results are consistent with a study by Park et al. (2015), which found no link between the use of emotional design and increased positive emotional states. However, the results of this study and those of Park et al. (2015) are in contrast with previous results in studies by Um et al. (2012) and Plass et al. (2014) which found that emotional design learning materials increased positive emotions in students. They also found that the positive emotions of the students did not change during the learning. In contrast, in this study the students' positive emotions did change. Heidig et al. (2015) also had results, where positive emotions were affected by the design of the learning materials.

5.1.2 Learning outcomes

The study found a significant difference between the learning outcomes of the students using two different exercise material variants. According to the results, those students who used the emotional design material on average received higher total points for the two learning outcome questions about object-oriented programming. This would mean that the colour and human-like shapes aided students learning

processes. This finding is in line with previous studies by (Um et al. 2012), (Plass et al. 2014), and Mayer & Estrella (2014). These studies showed that students with emotional design material performed better when tested for retention and comprehension and retention of the subject matter. But these studies showed no improvement in transfer of learned information. Study by Park et al. (2015), which looked at the interaction of emotional design material and inducted positive emotions, found no link between learning material variant and learning outcomes.

The results are promising, but there were some problems with these results. First, the grading of the students' answers was done by the writer of this thesis alone. This made the grading process highly subjective, even though the best effort was given to grade the answers along the guidelines described earlier in this thesis. Second point of concern was the highly varying level of students' answers and effort shown in them.

5.1.3 Perceived qualities of the learning materials

Attrakdiff 2 short was used to measure students' experience of the qualities of the learning materials. Students using emotional design material reported higher values for Hedonic quality - Stimulation than the student group using the traditional material variant. Hedonic quality - Stimulation included two semantic differentials: Dull-Captivating, and Creative-Unimaginative. The students saw the emotional design material variant as offering higher engagement. When the 10 semantic differential were individually tested, Creative-Unimaginative and Ugly-Beautiful were significantly higher for the emotional design material variant. Students' responses to the use of colours and human-like figures were positive, as they saw the material as more creative and beautiful. These two qualities can be presumed to increase the students' level of engagement when studying and be thus beneficial to learning materials. So this would support adding colour and human-like shapes to learning materials.

In their study (Heidig et al. 2015) studied the effect of applying web design principles to online learning materials. Students were given either expressive, classical or control variants of the learning material. Expressive and classical variants in that study were somewhat similar to emotional design in material variant in this test, as they used color. The control variant of that study is close to traditional design variant in this study, as it used grayscale scale color palette. Unlike in this study,

the material variants had no effect on the perceived qualities of the material, as the students viewed the materials similar when measured using Measurement Instrument of Perceived Visual Aesthetics of Websites by Lavie & Tractinsky (2004). Even though in their study they applied web design more holistically, the use of colour was the focus. For this thesis, the results were seen as comparable. The did not use human-like shapes, like in the study of this thesis. The shapes might be the reason why the two studies came to different outcomes. This would support the use of human-like shapes in learning materials.

To conclude, the emotional design learning material had the right elements to be able lower students negative affects while offering the same level of rise in positive affects as the traditional material variant. This study also found that using emotional design to design learning materials is beneficial to students learning outcomes. Students found the emotional design material variant to be more beautiful and creative than traditional material variant.

5.2 Effects of students' goal orientations

Students goal orientations were measured using Button's goal orientation questionnaire that gave values for students' mastery and performance goal orientations. The correlation of these two goal orientations with changes in students' emotional states, and learning outcomes were studied. The correlations were calculated within a material variant group, to remove the effect the emotional design might have on the results.

This part of the study was novel in the context and variables it covered. Previous studies in emotional design in the learning context did not study students' goal orientation per se, but motivation in general. Their focus was on another factors such directing students' attention to most important subject matter with illustrations, but not distracting them, like in study by (Mayer & Estrella 2014). These results are therefore compared to predictions provided by the theories of goal orientation, and not results of previous studies.

5.2.1 Changes in students' emotional states

In the data collected there was no correlation between either exercise material variant groups goal orientations and the change in their emotional states. The relationship

between the two variable was unknown, but was hypothesized at the start of this study to exist. The calculated correlations were between -0.11 and 0.076. The correlations in the data collected in this study quite strongly shows that we can't predict the impact learning materials have on students emotional state from their goal orientations.

In this study students with high mastery orientation didn't perform better or display greater positive affects, unlike was expected in accordance to study by (Kaplan & Maehr 2007).

5.2.2 Learning outcomes

There was no correlation between goal orientation and learning outcomes in the data. Beyond the calculated correlations we can make some observations about students' goal orientations and offer interpretations as to how students' goal orientations might be reflected in the answers they gave. Some students gave very well thought-out answers, while a few just left the questions empty, and one student had copied their answer directly from Wikipedia entry about object-oriented programming. These approaches can be seen to give some indication of students goals at the exercise, which speaks to students goal orientations and the subjective value of the exercise as seen by them. Here it is worth noticing that the points given for the exercise were not marked in the questionnaire, so the students did not have direct information about the level of reward and achievement they would receive for their efforts. But still some went to great lengths to answer in exemplary fashion. What motivated them? Of course, no certain answer can be given. But it can be argued that the students with high performance goal orientation gave high quality answers even to these questions where they could only presume the level of opportunity to demonstrate competence. A counter argument would be that the students with high mastery goal orientation would read through the learning material and see the questions as changes to apply what they had learned, organically resulting in high quality answers. But some students were not motivated to answer questions at all, or answered poorly. If the reason for the quality of their answers was the lacking knowledge, then the total points received give an indication of their learning outcomes. But if other motivational factors were at play and, for example, these students saw the exercise as offering them little new knowledge or not enough challenge, the total points would actually indicate their lacking motivation, not their failing at acquiring or applying new information. The effects of the material variant can

be seen as being a factor, the higher total points indicating that emotional design material provided had more elements that upheld the motivation of students.

Unlike in theories of goal orientation by Dweck & Leggett (1988), in the results of this study students performance goal orientation didn't correlate with higher points in the graded learning questions. So, the need of students to appear competent wasn't visible from the data.

To conclude there was no correlation between goal orientation and change in emotional states or learning outcomes in the study data. However, the role of goal orientation was hypothesized to play a role in the quality of the students' answers.

5.3 Validity and future research

The study setup was between groups study. Data gathered was mostly quantitative, consisting of students own assessments' of their emotional state, goal orientation and the qualities of the learning material in numeric form. The methods used were established, except for the Aalto questionnaire. But the Aalto questionaire too had been previously used in a study and was found unproblematic.

The validity of the results from the questionnaires could have been compromised, as they needed to be translated from English to Finnish and for Button's goal orientation questionnaire there was no available Finnish translations. Also the translation of the scales endpoints and the fact that not all of the scale points were given verbal cues might have caused problems for the validity of the results. Reliability of the study is supported by the fact that complete questionnaires and the database of the answers is available to those who wish to replicate the study.

Validity of the results might compromised by the fact that the students were unevenly distributed in view of their starting years of studies and study points. Now emotional design material variant group had more experienced students. These students might already have knowledge and thus can direct their attention differently in the material, or as previously speculated in learning outcomes, just leaf through the material. But the emotional design elements in the material made the material more appealing, which might have motivated them to study more thoroughly. Future research should be conducted where the possible influence the starting year and/or study points have are eliminated.

The effect Emotional design and students' goal orientations have on emotions and learning outcomes was furthered in this thesis, but no definitive results were found. Emotional design should be applied more comprehensibly. In online environments the studied attributes of the learning materials should not be limited to just illustrations. The use of web design principles in a study by Heidig et al. (2015) is an example of more holistic approach. The research on learning and the many interacting attributes of students, learning materials and the contexts of learning would benefit from greater understanding of the role of emotions and goal orientation in learning.

REFERENCES

Bradley, M. M. & Lang, P. J. (1994), 'Measuring emotion: The self-assessment manikin and the semantic differential', *Journal of Behavior Therapy and Experimental Psychiatry* **25**(1), 49 – 59.
URL: *http://www.sciencedirect.com/science/article/pii/0005791694900639*

Button, S. B., Mathieu, J. E. & Zajac, D. M. (1996), 'Goal orientation in organizational research: A conceptual and empirical foundation', *Organizational Behavior and Human Decision Processes* **67**(1), 26 – 48.
URL: *http://www.sciencedirect.com/science/article/pii/S0749597896900631*

Calvo, R. A. & D'Mello, S. (2010), 'Affect detection: An interdisciplinary review of models, methods, and their applications', *Affective Computing, IEEE Transactions on* **1**(1), 18–37.

Crawford, J. R. & Henry, J. D. (2004), 'The positive and negative affect schedule (panas): Construct validity, measurement properties and normative data in a large non-clinical sample', *British Journal of Clinical Psychology* **43**(3), 245.

Desmet, P. (2005), Measuring emotion: Development and application of an instrument to measure emotional responses to products, *in* 'Funology', Springer, pp. 111–123.

Dirkx, J. M. (2001), 'The power of feelings: Emotion, imagination, and the construction of meaning in adult learning.', *New Directions for Adult & Continuing Education* **2001**(89), 63.

D'Mello, S. & Graesser, A. (2012), 'Dynamics of affective states during complex learning', *Learning and Instruction* **22**(2), 145 – 157.
URL: *http://www.sciencedirect.com/science/article/pii/S0959475211000806*

Dweck, C. S. & Leggett, E. L. (1988), 'A social-cognitive approach to motivation and personality.', *Psychological Review* **95**(2), 256–273.

Ekkekakis, P. (2012), Affect, mood, and emotion, *in* 'The measurement of affect, mood, and emotion in exercise psychology.', Human Kinetics, pp. 321–332.

Ekman, P. (1999), Basic emotions, *in* 'Handbook of cognition and emotion', Wiley Online Library, pp. 45–60.

Elliot, A. J. & McGregor, H. A. (2001), 'A 2× 2 achievement goal framework.', *Journal of personality and social psychology* **80**(3), 501.

Gross, J. J. (2010), 'The future's so bright, i gotta wear shades', *Emotion Review* **2**(3), 212–216.

Haaranen, L., Ihantola, P., Sorva, J. & Vihavainen, A. (2015), In search of the emotional design effect in programming, *in* '37th IEEE/ACM International Conference on Software Engineering, ICSE 2015, Florence, Italy, May 16-24, 2015, Volume 2', pp. 428–434.
URL: *http://dx.doi.org/10.1109/ICSE.2015.175*

Hassenzahl, M. & Monk, A. (2010), 'The inference of perceived usability from beauty', *Human–Computer Interaction* **25**(3), 235–260.

Heidig, S., Müller, J. & Reichelt, M. (2015), 'Emotional design in multimedia learning: Differentiation on relevant design features and their effects on emotions and learning', *Computers in Human Behavior* **44**, 81 – 95.
URL: *http://www.sciencedirect.com/science/article/pii/S0747563214005883*

ISO (1998), Ergonomic requirements for office work with visual display terminals vdts – part 11: Guidance on usability, ISO ISO 9241-11:1998, International Organization for Standardization, Geneva, Switzerland.

ISO (2010), Ergonomics of human-system interaction – part 210: Human-centred design for interactive systems, ISO ISO 9241-210:2010, International Organization for Standardization, Geneva, Switzerland.

Izard, C. E. (2010), 'The many meanings/aspects of emotion: Definitions, functions, activation, and regulation', *Emotion Review* **2**(4), 363–370.

Jack, R. E., Garrod, O. G. & Schyns, P. G. (2014), 'Dynamic facial expressions of emotion transmit an evolving hierarchy of signals over time', *Current Biology* **24**(2), 187–192.
URL: *http://dx.doi.org/10.1016/j.cub.2013.11.064*

Kaplan, A. & Maehr, M. L. (2007), 'The contributions and prospects of goal orientation theory', *Educational Psychology Review* **19**(2), 141–184.

Kleinginna, Paul R., J. & Kleinginna, A. M. (1981), 'A categorized list of emotion definitions, with suggestions for a consensual definition', *Motivation and Emotion* **5**(4), 345–379.
URL: *http://dx.doi.org/10.1007/BF00992553*

Lavie, T. & Tractinsky, N. (2004), 'Assessing dimensions of perceived visual aesthetics of web sites', *Int. J. Hum.-Comput. Stud.* **60**(3), 269–298.
URL: *http://dx.doi.org/10.1016/j.ijhcs.2003.09.002*

Law, E. L.-C., Roto, V., Hassenzahl, M., Vermeeren, A. P. & Kort, J. (2009), Understanding, scoping and defining user experience: A survey approach, *in* 'Proceedings of the SIGCHI Conference on Human Factors in Computing Systems', CHI '09, ACM, New York, NY, USA, pp. 719–728.
URL: *http://doi.acm.org/10.1145/1518701.1518813*

Mayer, R. E. & Estrella, G. (2014), 'Benefits of emotional design in multimedia instruction', *Learning and Instruction* **33**, 12 – 18.
URL: *http://www.sciencedirect.com/science/article/pii/S0959475214000231*

Navarro, O., Molina, A. I., Lacruz, M. & Ortega, M. (2015), 'Evaluation of multimedia educational materials using eye tracking', *Procedia - Social and Behavioral Sciences* **197**, 2236 – 2243. 7th World Conference on Educational Sciences.
URL: *http://www.sciencedirect.com/science/article/pii/S1877042815043670*

Norman, D. A. (2005), *Emotional Design*, Basic Books.

Park, B., Knörzer, L., Plass, J. L. & Brünken, R. (2015), 'Emotional design and positive emotions in multimedia learning: An eyetracking study on the use of anthropomorphisms', *Computers & Education* **86**, 30 – 42.
URL: *http://www.sciencedirect.com/science/article/pii/S036013151500069X*

Pekrun, R., Goetz, T., Titz, W. & Perry, R. P. (2002), 'Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research', *Educational psychologist* **37**(2), 91–105.

Plass, J. L., Heidig, S., Hayward, E. O., Homer, B. D. & Um, E. (2014), 'Emotional design in multimedia learning: Effects of shape and color on affect and learning', *Learning and Instruction* **29**, 128 – 140.
URL: *http://www.sciencedirect.com/science/article/pii/S0959475213000273*

Russell, J. A. (2003), 'Core affect and the psychological construction of emotion.', *Psychological review* **110**(1), 145.

Russell, J. A. & Barrett, L. F. (1999), 'Core affect, prototypical emotional episodes, and other things called emotion: dissecting the elephant.', *Journal of personality and social psychology* **76**(5), 805.

Shaver, P., Schwartz, J., Kirson, D. & O'Connor, C. (1987), 'Emotion knowledge: Further exploration of a prototype approach.', *Journal of Personality and Social Psychology* **52**(6), 1061–1086.

Shouse, E. (2005), 'Feeling, emotion, affect', *M/c journal* **8**(6), 26.

Thompson, E. R. (2007), 'Development and validation of an internationally reliable short-form of the positive and negative affect schedule (panas)', *Journal of Cross-Cultural Psychology* **38**(2), 227–242.
URL: *http://opus.bath.ac.uk/11965/*

Um, E., L., P. J., O., H. E. & Homer, B. D. (2012), 'Emotional design in multimedia learning.', *Journal of Educational Psychology* **104(2)**, 485 – 498.

Urdan, T., Ryan, A. M., Anderman, E. M. & Gheen, M. H. (2002), 'Goals, goal structures, and avoidance behaviors', *Goals, goal structures, and patterns of adaptive learning* **17**, 311.

Vandewalle, D. (1997), 'Development and validation of a work domain goal orientation instrument', *Educational and Psychological Measurement* **57**(6), 995–1015.
URL: *http://epm.sagepub.com/content/57/6/995.abstract*

Weiner, B. (1985), 'An attributional theory of achievement motivation and emotion.', *Psychological review* **92**(4), 548.

APPENDIX A. DEMOGRAPHIC QUESTIONNAIRE IN FINNISH

Esikysely 1 / 5

Taustatiedot

Tähtimerkki (*) kysymyksen perässä tarkoittaa pakollista kysymystä. Sinun on vastattava sivun pakollisiin kysymyksiin ennen kuin voit jatkaa.

Sukupuoli*	Mies
Ikä*	23
Opiskeluiden aloitusvuosi*	2014
Pääaine*	Tietotekniikka
Opintopisteet*	24
Kaikkien kurssien keskiarvo*	3.2

Jatka

Tarvittaessa voit tarkistaa opintotietosi POP:sta.
(https://idp.tut.fi/idp/Authn/UserPassword)

APPENDIX B. COURSE MATERIAL QUESTIONNAIRE - ATTRAKDIFF2 SHORT

Esikysely 2 / 5

Kurssin oppimateriaalin arviointi

Lue seuraavat ohjeet huolellisesti.

Tällä kyselylomakkeella voit arvioida tällä kurssilla käytettyä oppimateriaalia.

Kysely muodostuu sanapareista, joiden avulla voit arvostella kurssilla käytettyä opetusmateriaalia. Jokainen sanapari muodostuu sanoista jotka edustavat asteikon ääripäitä. Sanaparien välissä oleva asteikko 1 - 7 antaa sinulle mahdollisuuden kuvata kyseisen sanaparin edustaman ominaisuuden kokemuksesi voimakkuutta. Jos esimerkiksi valitset sanaparin Sekainen - Selkeä asteikosta arvon 5, tämä kuvaa sitä, että koet kurssimateriaalin olleen kokonaisuudessaan suurimmalta osin selkeää, mutta että vähäistä parannusta on mahdollista tehdä.

Älä käytä aikaa sanaparien pohtimiseen. Anna spontaani vastauksesi. Voit kokea, etteivät kaikki sanaparit riittävästi kuvaa kurssimateriaalia. Anna kuitenkin tällaisessakin tilanteessa vastauksesi. Pidä mielessä, ettei ole oikeata tai väärä vastausta. Oma mielipiteesi on se millä on väliä!

Käytä alla olevia sanapareja apunasi valitse asteikkojen arvot, jotka mielestäsi parhaiten kuvaavat kurssimateriaalia. Muista valita arvo jokaiselle sanaparille!

	1	2	3	4	5	6	7	
Sekava	○	◉	○	○	○	○	○	Selkeä
Epäkäytännöllinen	○	○	○	○	○	◉	○	Käytännöllinen
Yllätyksellinen	○	○	◉	○	○	○	○	Ennustettava
Monimutkainen	○	○	◉	○	○	○	○	Yksinkertainen
Tylsä	○	○	○	○	○	◉	○	Tarttuva

	1	2	3	4	5	6	7	
Mauton	○	○	○	○	◉	○	○	Tyylikäs
Halpa	○	○	○	○	○	◉	○	Ensiluokkainen
Mielikuvitukseton	○	○	◉	○	○	○	○	Luova
Ruma	○	○	○	○	○	◉	○	Kaunis
Huono	○	◉	○	○	○	○	○	Hyvä

Olet vastannut 10 / 10

Jatka

APPENDIX C. GOAL ORIENTATION QUESTIONNAIRE (BUTTON)

Esikysely 3 / 5

Tavoiteorientaatio

Tällä kyselyllä kartoitetaan oppimiseen liittyviä tavoiteorientaatiotasi. Kysely muodostuu 16 väittämästä. Jokaisen väittämän kohdalla lue ensin väittämä ja valitse sitten numero joka kuvaa väitteen soveltumista itseesi. Arvot ovat arvoväliltä 1 (Täysin eri mieltä) ja 6 (Täysin samaa mieltä).

Tähtimerkki (*) kysymyksen perässä tarkoittaa pakollista kysymystä. Sinun on vastattava sivun pakollisiin kysymyksiin ennen kuin voit jatkaa.

1. Teen mieluummin asioita, joita osaan tehdä hyvin kuin asioita, joita osaan huonosti.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

2. Olen onnellisin opinnoissani kun teen tehtäviä, joissa tiedän etten tee virheitä.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

3. Tehtävät, joista nautin eniten, ovat ne tehtävät jotka teen parhaiten.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

4. Muiden mielipiteet osaamisestani ovat minulle tärkeitä.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

5. Tunnen itseni älykkääksi, kun teen jotain ilman virheitä.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

6. Haluan olla kohtalaisen varma, että kykenen suoriutumaan tehtävästä ennen kuin yritän sitä.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ○ ○ ◉ ○

7. Minulle on mieluista tehdä tehtäviä joiden kaltaisissa olen onnistunut hyvin aiemmin.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ○ ○ ○ ◉

8. Tunnen itseni älykkääksi, kun osaan suorittaa jonkin tehtävän paremmin kuin muut.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ○ ◉ ○ ○

9. Mahdollisuus suorittaa haastavia tehtäviä on minulle tärkeää.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ◉ ○ ○ ○

10. Kun epäonnistun vaikean tehtävän suorittamisessa, suunnittelen seuraavalla kerralla yrittäväni kovemmin.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ○ ○ ◉ ○

11. Suosin tehtäviä, joissa minun on pakko opetella uusia asioita.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ○ ◉ ○ ○

12. Mahdollisuus oppia uutta on minulle tärkeää.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

○ ○ ○ ○ ○ ◉ ○

13. Työskentelen parhaiten, kun olen tekemässä suhteellisen vaikeaa tehtävää.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

14. Pyrin kovasti parantamaan aikaisemmista suorituksistani.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

15. Mahdollisuus parantaa kykyjeni rajoja on minulle tärkeää.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

16. Kun minulla on vaikeuksia jonkin ongelman ratkaisemisessa, nautin siitä kun voin kokeilla ja vertailla erilaisia lähestymistapoja ongelman ratkaisemiseksi.*

Täysin eri mieltä 1 2 3 4 5 6 7 Täysin samaa mieltä

Olet vastannut 16 / 16

Jatka

APPENDIX D. PROGRAMMING EXPERIENCE QUESTIONNAIRE

Esikysely 4 / 5

Ohjelmoinnin taustatiedot

Tähtimerkki (*) kysymyksen perässä tarkoittaa pakollista kysymystä. Sinun on vastattava sivun pakollisiin kysymyksiin ennen kuin voit jatkaa.

Kerro ohjelmointiin liittyvästä kokemuksestasi.

1. Olen ohjelmoinut ennen tätä kurssia:*

Päivittäin	Viikottain	Kuukausittain	Harvemmin	En ollenkaan
○	◉	○	○	○

2. Olen olio-ohjelmoinut (object-oriented programming) ennen tätä kurssia:*

Päivitäin	Viikottain	Kuukausittain	Harvemmin	En ollenkaan
○	○	○	◉	○

3. Ohjelmoin vapaa-ajallani:*

Päivittäin	Viikottain	Kuukausittain	Harvemmin	En ollenkaan
○	◉	○	○	○

4. Luen vapaa-ajallani ohjelmointiin liittyviä materiaaleja tai nettisivuja:*

Päivittäin	Viikottain	Kuukausittain	Harvemmin	En ollenkaan
○	○	○	◉	○

5. Osaan nimetä ohjelmointikieliä:*

0	1	2 - 3	4 tai useampia
○	◉	○	○

6. Osaan nimetä ohjelmointityylejä ja -paradigmoja:*

0	1	2 tai 3	4 tai enemmän
○	○	◉	○

Olet vastannut 6 / 6

Jatka

APPENDIX E. I-PANAS-SF QUESTIONNAIRE

Esikysely 5 / 5

Tunnetila

Tällä kyselyllä kartoitetaan tämänhetkistä tunnetilaasi. Kysely muodostuu kymmenestä eri tunteesta, joiden kokemisen voimakkuutta sinun tulee arvioida asteikolla 1 (ei ollenkaan) - 7 (erittäin voimakkaasti).

Tähtimerkki (*) kysymyksen perässä tarkoittaa pakollista kysymystä. Sinun on vastattava sivun pakollisiin kysymyksiin ennen kuin voit jatkaa.

Kysymys: Kun ajattelet itseäsi ja sitä mitä tunnet tällä hetkellä, missä määrin tunnet että olet:

1. Järkyttynyt*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

2. Hermostunut*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

3. Valpas*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

4. Nolostunut*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

5. Inspiroitunut*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

6. Tarkkaavainen*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

7. Vihamielinen*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

8. Päättäväinen*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

9. Pelokas*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

10. Aktiivinen*

Ei ollenkaan 1 2 3 4 5 6 7 Paljon

Olet vastannut 10 / 10

Jatka

APPENDIX F. EXERCISE ONLINE MATERIAL ATTRAKDIFF2 SHORT QUESTIONNAIRE

Jälkikysely 2 / 3

Tämän harjoituskerran oppimateriaalin arviointi

Lue seuraavat ohjeet huolellisesti.

Tällä kyselylomakkeella voit arvioida juuri läpikäymääsi, tämän harjoituskerran oppimateriaalia.

Kysely muodostuu sanapareista, joiden avulla voit arvostella juuri läpikäymääsi, tämän harjoituskerran oppimateriaalia. Jokainen sanapari muodostuu sanoista jotka edustavat asteikon ääripäitä. Sanaparien välissä oleva asteikko 1 - 7 antaa sinulle mahdollisuuden kuvata kyseisen sanaparin edustaman ominaisuuden kokemuksesi voimakkuutta. Jos esimerkiksi valitset sanaparin Sekainen - Selkeä asteikosta arvon 5, tämä kuvaa sitä, että koet juuri läpikäymääsi, tämän harjoituskerran oppimateriaalin olleen kokonaisuudessaan suurimmalta osin selkeää, mutta että vähäistä parannusta on mahdollista tehdä.

Älä käytä aikaa sanaparien pohtimiseen. Anna spontaani vastauksesi. Voit kokea, etteivät kaikki sanaparit riittävästi kuvaa juuri läpikäymääsi, tämän harjoituskerran oppimateriaalia. Anna kuitenkin tällaisessakin tilanteessa vastauksesi. Pidä mielessä, ettei ole oikeata tai väärä vastausta. Oma mielipiteesi on se millä on väliä!

Käytä alla olevia sanapareja apunasi valitse asteikkojen arvot, jotka mielestäsi parhaiten kuvaavat juuri läpikäymääsi, tämän harjoituskerran oppimateriaalia. Muista valita arvo jokaiselle sanaparille!

Käytä alla olevia sanapareja apunasi valitse asteikkojen arvot, jotka mielestäsi parhaiten kuvaavat *juuri läpikäymääsi, tämän harjoituskerran oppimateriaalia*. Muista valita arvo jokaiselle sanaparille!

	1	2	3	4	5	6	7	
Sekava	○	○	◉	○	○	○	○	Selkeä

	1	2	3	4	5	6	7	
Epäkäytännöllinen	○	○	○	○	○	◉	○	Käytännöllinen

	1	2	3	4	5	6	7	
Yllätyksellinen	○	○	◉	○	○	○	○	Ennustettava
Monimutkainen	○	○	○	○	○	◉	○	Yksinkertainen
Tylsä	○	○	◉	○	○	○	○	Tarttuva
Mauton	○	○	○	○	◉	○	○	Tyylikäs
Halpa	○	○	○	○	○	◉	○	Ensiluokkainen
Mielikuvitukseton	○	○	○	○	○	○	◉	Luova
Ruma	○	○	○	◉	○	○	○	Kaunis
Huono	○	○	○	○	○	◉	○	Hyvä

Olet vastannut 10 / 10

Jatka

APPENDIX G. AALTO UNIVERSITY STUDY'S QUESTIONNAIRE - UX AND LEARNING OUTCOMES

Jälkikysely 3 / 3

Viikkoharjoitustehtävät

Viikkoharjoitustehtävä 10.1: Lukemasi perusteella, kerro mitä olio-ohjelmoinnilla tarkoitetaan.

Ohjelma jaetaan loogisiin osiin, joilla on omat vastuunsa ja sisäiset tietonsa ja joiden välisellä kommunikaatiolla voidaan muodostaa ohjelmia.

Olisitko osannut vastata viikkoharjoitustehtävään 10.1 ennen kuin kävit läpi tämän harjoituksen oppimateriaalin?*

Kyllä	Ei
○	◉

Viikkoharjoitustehtävä 10.2: Minkälaisia olioita käyttäisit ohjelmassa, jonka tehtävänä olisi pitää kirjaa hotellin huonevarauksista? Anna yksi esimerkki siitä, miten nämä oliot keskustelevat keskenään?

Varaus, Huone, Hotelli, Kerros

Olisitko osannut vastata viikkoharjoitustehtävään 10.2 ennen kuin kävit läpi tämän harjoituksen oppimateriaalin?*

Kyllä	Ei
◉	○

Viikkoharjoitustehtävä 10.3: (oppimateriaalin laadun tutkimukseen liittyviä kysymyksiä)

Kuinka keskittyneesti luit oppimateriaalia? (1 - hyvin keskittyneesti, 5 - ei lainkaan keskittyneesti)

○ **1 - hyvin keskittyneesti**

- (•) **2**
- ( ) **3**
- ( ) **4**
- ( ) **5 - ei lainkaan keskittyneesti**

Kuinka ymmärrettävää oppimateriaali oli? (1 - hyvin helposti ymmärrettävää, 5 - hyvin vaikeasti ymmärrettävää)

- ( ) **1 - hyvin helposti ymmärrettävää**
- ( ) **2**
- ( ) **3**
- (•) **4**
- ( ) **5 - hyvin vaikeasti ymmärrettävää**

Kuinka miellyttävää oppimateriaali oli? (1 - hyvin miellyttävää, 5 - ei lainkaan miellyttävää)

- ( ) **1 - hyvin miellyttävää**
- (•) **2**
- ( ) **3**
- ( ) **4**
- ( ) **5 - ei lainkaan miellyttävää**

Materiaalin kuvitus auttoi ymmärtämään opittavaa asiaa. (1 - täysin samaa mieltä, 5 - täysin eri mieltä)

- ( ) **1 - täysin samaa mieltä**
- ( ) **2**
- (•) **3**
- ( ) **4**
- ( ) **5 - täysin eri mieltä**

Materiaalin kuvitus oli miellyttävää. (1 - täysin samaa mieltä, 5 - täysin eri mieltä)

- ( ) **1 - täysin samaa mieltä**
- ( ) **2**

- ○ **3**
- ◉ **4**
- ○ **5 - täysin eri mieltä**

Vapaata palautetta materiaalista

Pedagogisesti timanttia!

Jatka